School Science and Mathematics

Vol. XXXVIII November, 1938 Whole No. 334

THE THIRTY-EIGHTH CONVENTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS, INC.

On November 25 and 26 the teachers of the basic sciences of all the middle west will meet in annual convention at the La Salle Hotel in Chicago. On pages 927–934 of this issue an outline of the convention program is given. It is the result of the combined effort through several months of about forty officers and members led by President Ira C. Davis. Seventy speakers, coming from twelve different states and representing forty-five famous institutions of learning and twenty great industrial and commercial concerns, take part in the various programs. Whatever is new in subject matter or in method of presentation will be discussed and demonstrated. No convention in the history of the Association has made such elaborate preparation for displaying and demonstrating new books and teaching devices. In addition to the regular displays in the exhibitors' booths noted scientists will give short lectures on the latest devices for laboratory, museum, and class room teaching. Each section program on Friday afternoon provides time for a discussion and display of the materials for objective teaching. A new feature is the group meetings on Saturday morning, which will give special emphasis to teaching at the various grade levels from elementary school to junior college.

Read over the program given elsewhere in this issue, then show it to your non-member associates. Many schools are planning for 100% membership and attendance.

Glen W. Warner

THE CONIC COMPASS

By John L. C. Löf
University of Denver, Denver, Colorado

If a point be made to move on the intersection of a right circular cone and a plane, it will describe one of the conic sections. An instrument based upon this principle has been constructed with which it is possible to draw conic sections and to illustrate their properties. This device is shown in Fig. 1. Rods BP rotate about the axis of the cone GA so that they may be considered as elements generating the cone. Point P then always lies on the surface of a cone and can move on a plane of paper so as to draw any desired conic section. Such an instrument will obviously be of value in mathematical instruction.

Mechanical Construction

For P to move on a cone, the two parallel rods BP, one on each side of the axis, are joined at their upper ends B and also at the lower ends P where a pencil point is attached. (See Fig. 2.) These rods slide freely in cradle C thru bearings at D and E. Cradle C is able to slide on GA and also to rotate about it. However, collar F may be set at any position on GA and thus permit C only to rotate about the axis. Then for any setting of F, the point P is free to move on a certain cone whose axis is GA. The axis is supported by a framework and legs HL.

The point P is bent into the shape shown in Fig. 1 so that it may be brought up very close to the axis for curves that are very narrow. This shape is found to work best for most curves, but for some hyperbolas of large eccentricity, the rods must be turned over so that P bends the other way.

The mechanical construction of the cradle is of most interest because it is essential that the point move on the cone whose axis is GA. Obviously, one rod used for BP would not work because it would then have to pass through GA; hence, two rods are used so that they may pass around it.

An inexpensive and serviceable instrument of this sort may be constructed out of an ordinary set of structural toys. However, a more satisfactory one for accurate work should be made of cast iron to give it weight and rigidity. For ordinary work a rather good height of the legs is twenty inches and the rods BP about twelve inches long.

Theory

The device provides a convenient way of illustrating the conics and showing their relation to the cone. The eccentricity of a conic section as applied to this instrument may be defined as (see Fig. 1):

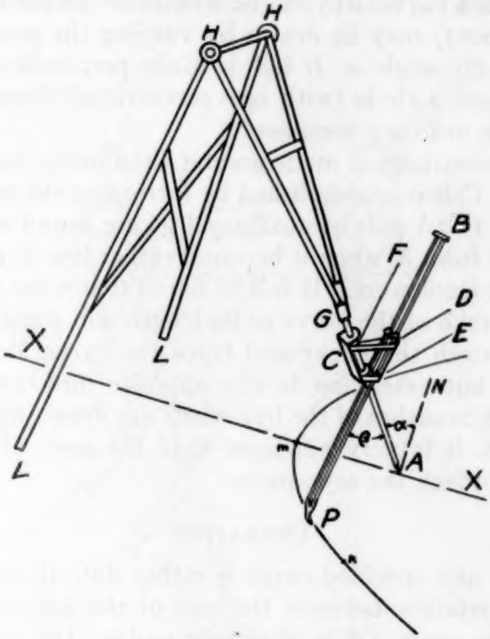


FIG. 1. Conic compass.

$$e=\frac{\sin \alpha}{\cos \beta}, \text{ where:} \tag{1}$$

α = angle between normal NA to plane at A and axis AG,
$\beta = 1/2$ the angle at the vertex of a right circular cone.

In the case of the parabola, which has an eccentricity of unity;

$$\sin \alpha = \cos \beta, \text{ and } \alpha = 90° - \beta.$$

As the angle β is fixed, α is adjusted by swinging end B down below H and changing the position of legs L until BP can be made horizontal and parallel to XX; that is, one element of the cone is parallel to the intersecting plane. A parabola is then drawn by moving point P on the paper on both sides of the line XX. In this way a whole family of parabolas may be drawn using the

same position of A and changing the position of the collar F for each curve.

If angle α is decreased, P will draw a complete closed curve, an ellipse, since the eccentricity is less than unity. Every setting of α will give a family of ellipses by changing the position of the collar for each curve. Any ellipse whatever (within the range of the instrument) may be drawn by varying the position of the collar and the angle α. If GA is made perpendicular so that $\alpha = 0$, we have a circle (with zero eccentricity) drawn with the action of an ordinary compass.

If the eccentricity is made greater than unity, an hyperbola will result. This is accomplished by increasing the angle α, that is lowering G. (A pair of auxiliary legs are found necessary to be dropped from H when it becomes rather low to prevent collapse of the framework.) It will be found that when point P has drawn as much of the curve as its length will reach, the end B will then touch the paper and trace the curve identical with that of P but extending in the opposite direction. In other words, both branches of the hyperbola are drawn by the instrument! Also, it is very apparent that the ends of the curves rapidly approach the asymptotes.

Operation

To draw any specified curve is rather difficult since there is no simple relation between the end of the axis A and other parts of the conic. (A is obviously neither the focus nor the center of the curve.) The eccentricity may be computed for the desired curve by using equation (1). Then the angle α can be set by the use of a suitable scale device placed at H. By making the legs HL equal to HA, we have:

$$\angle LHA = 2 \cdot \alpha, \text{ and } 1/\cos \beta = \text{a constant} = C.$$

Therefore, from equation (1):

$$e = C \cdot \sin\left(\frac{\angle LHA}{2}\right) \cdot \qquad (2)$$

The instrument is adjusted to give the desired eccentricity by the use of a scale placed at H calibrated in values of eccentricity by the above equation. To locate exactly the position of the point A would require the solution of an involved equation; however, for practical purposes, this may be avoided by a trial and error method.

With the eccentricity adjusted as desired, and the frame clamped in this position, the axis of the curve XX and the end m are located. A is then placed at some point inside the desired curve on XX, and the legs L are set on opposite sides of the axis at equal distances from it. Any other point which is to lie on the curve aside from m such as k is also located, and cradle

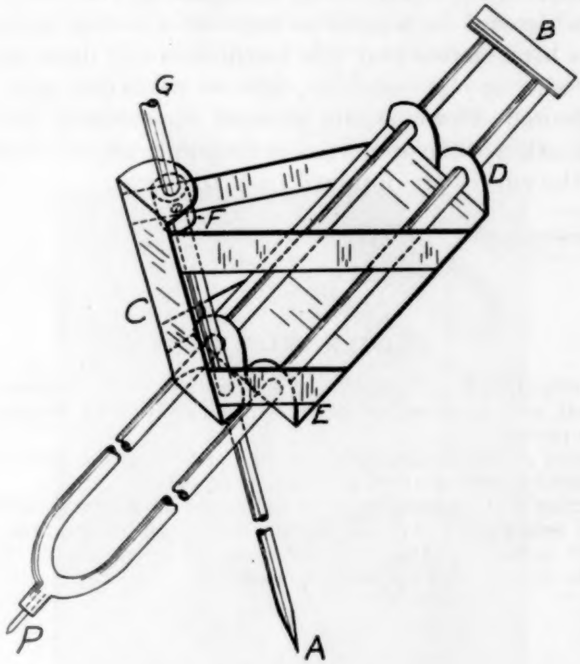


FIG. 2. Detail of drawing cradle.

C is moved on GA until P will touch k. Then collar F is clamped and a trial is made to determine whether P can also fall on m for this position of F (and the same eccentricity). If not the position of A on XX and F on GA must be readjusted until P will touch both k and m. Then by rotating P about on the paper, the desired curve is drawn.

It is found most convenient to make angle β approximately 45° and then equation (2) becomes:

$$e = \frac{1}{\cos 45^\circ} \cdot \sin\left(\frac{\angle LHA}{2}\right) = 1.4 \sin\left(\frac{\angle LHA}{2}\right). \qquad (3)$$

From this equation the scale at H is calibrated.

The idea of the Conic Compass is based on that of the Elliptical Compass* which operates on the principle that the intersection of a cylindrical surface and a plane is an ellipse. Such an instrument has a point moving on the surface of a cylinder, that is, at a constant distance from the axis and sliding on it. It then moves on the plane of the paper to describe the ellipse. The achievement of the Conic Compass is, therefore, that it provides a means for a point to move on a conical surface.

It has been shown that this instrument can draw any conic section with any eccentricity, and in particular any specific curve desired. However, its greatest opportunity lies in the demonstration of the properties of the conics and the illustration of how the curves are obtained from the cone.

* Mathematical Dictionary—Davies & Peck—1875, p. 112.

LARGER STOP SIGNS

Increasing the size of stop signs at intersections cuts violations by 50 to 75 per cent, an experiment reported at Lansing, Mich. by Murray D. Van Wagoner reveals.

Replacing a 24-inch sign with a 36-inch one, violations were cut in half by day and by three-quarters at night, he reports.

Suspecting that the novelty of the sign might have something to do with the good behavior of approaching motorists, the observations were repeated 30 days later. This time violations were reduced by 70 per cent during the day and by 77 per cent at night.

PYTHAGORAS

By Felicite M. Mueller
High School Student, Sheboygan, Wis.

Pythagoras, thou ancient honored man,
Philosopher, thou Sage of Samos isle,
Geometer, measurer of many a span,
Journeyer to far Egypt and the Nile,
Believer in the system of numbers,
Savant, subscriber to a fancy-flight—
The thought that man's soul in a beast slumbers—
Dispeller of darkness, Bringer of light,
Thou with thy soul's swift song, intense, vibrant,
Thou with thy monochord, thy stretchèd wire,
Thy intervals, octave and dominant,
Thou wert a player on the eight-string'd lyre.
'Twas thou alone, of all of us, whose ears,
Attuned, discerned the music of the spheres.

AN EXPERIMENT IN ELEMENTARY OPTICS

By Vinton Phenix
Greeley, Colorado

Here is an interesting experiment in reflection by a concave mirror. It is a useful exercise for the student to explain the results obtained in each step. It will help him to understand more clearly the mechanism of reflection and in particular to see how the inversion of the image comes about.

Prepare a card approximately 21″ high by 6″ wide with seven transverse bands of 3″ each having the seven colors of the rainbow and in the center of each place say the letter "T."

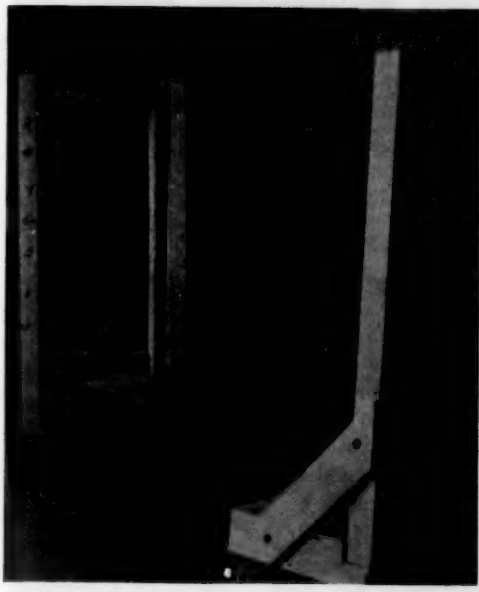


Fig. 1

Look at the reflection of this card in a plane mirror made of a sheet of bright tin approximately 6″ wide by 14″ high. The colors appear in their proper order and the letters are in their normal position. (See Fig. 1.)

Next look at the image of the card in a concave mirror. This is the same mirror depressed. The distance between card of colors and mirror is approximately 14″. Watch the transition which takes place as you change the plane mirror into a concave mirror. The colors and letters appear inverted. (See Fig. 2.)

FIG. 2

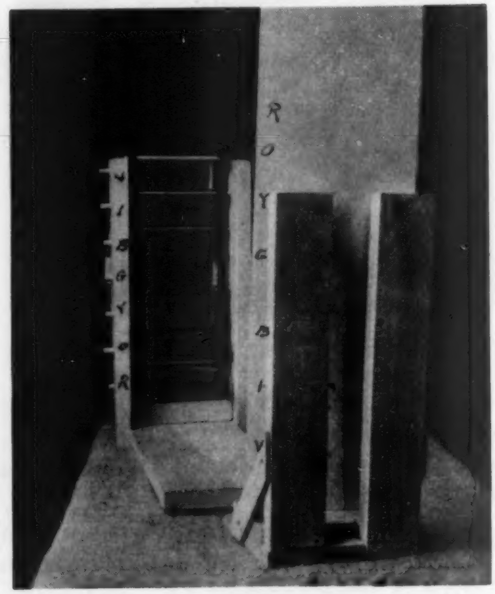


FIG. 3

Next place seven plane mirrors say 6″ wide by $1\frac{1}{2}$″ high made of the same material or strips of cheap glass mirror to be readily obtained at the glass store, along the curve of the concave mirror in the last step as shown in Fig. 3. Here the colors will appear in reversed order but the letters will be upright.

Let the student consider what would happen if, instead of seven mirrors, a large number (say a thousand) of small plane mirrors, in the form of narrow strips, were placed along the curve of the concave mirror. Why would the result in this case differ from the case of seven mirrors, and why would it be similar to the case of the continuous concave mirror?

MIGRATION OF THE REDWOODS

The world's greatest migration, which involved the biggest and the oldest of all living things and covered some 75,000,000 years of time, will be depicted to visitors of the Hall of Science at the 1939 Golden Gate Exposition on San Francisco Bay. The individuals of this migration, the giant redwoods of California, will be shown as they cut a wide arboreal corridor for themselves through the fierce wastes and jungles of earliest geologic times, reaching from the Arctic to what is now California.

This display, which will be part of the University of California's exhibit at the $50,000,000 World's Fair of the West, should effectively topple over the widespread belief that the great redwoods were always in California. With appropriate proofs the display will show that at one time in the earth's geologic and paleontologic history, the big trees grew many thousands of miles away from their present last stand.

The exhibit will place them first in the Arctic wastes where they first appeared, and where they grew as big around and as tall as they grow in California. Then it will show how their seed was carried or blown ever southward by swarms of rodents or by the vagrant winds, how the oldest and weakest of the tree individuals were killed off by advancing cold and how the new ones grew luxuriantly as they progressed toward the warm climes below the Arctic Circle.

The two phases of this greatest of migrations will be shown, one illustrating the manner in which the ancestors of the trees now in California, started on their way from Northernmost Alaska, or its Miocene and Eocene equivalent, and the others started from elsewhere along the Arctic Circle and progressed through Iceland and Greenland to Europe, where they became extinct.

This "moving" drama of antiquity will be plotted on a map now being prepared by the Department of Paleontology under the direction of Dr. R. W. Chaney, its director. At each key point in the migration small paintings of the redwoods will be shown. A side exhibit will include specimens of both the modern redwoods and their fossil ancestors, gathered along the path of this greatest of migrations. The entire exhibit will be part of the botany exhibit in the Hall of Science.

CULTURAL LANDSCAPES

By Walter Hansen
North Texas State Teachers College, Denton, Texas

A new technique of investigation is always of interest to the scientist, and particularly so to the geographer interested in field work. The technique suggested here may be used by the grade school teacher in the study of the "home region" as well as by the graduate student interested in advanced degrees.

While the study of regional geography through the medium of cultural landscapes seems to be new in the United States, this method of approach has gained considerable importance among European geographers. Jean Bruhnes, in his remarkable book, *Human Geography*, frequently points out that the material works of man are "essential facts" in any geographic study. He says, for example: "Human Geography . . . must be first and above all the geography of material human works; it is also the geography of human masses and human races, but only in so far as masses and races express their specific and distinctive modes of activity by material works, and in so far as they reveal their existence and their presence by these same words."[1] P. W. Bryan, in his book, *Man's Adaptation of Nature*, suggests that through the medium of cultural features the geographer has at hand a measuring rod by means of which the environmental factors which affect human activity may be selected.[2] In a recent book on *The Making of Geography*, R. E. Dickinson and O. J. R. Howarth conclude that "The essence of geography is the explanatory description of human occupance within composite natural regions."[3]

In 1934, the writer presented to the University of Nebraska a Doctor's Dissertation entitled "Cultural Landscapes of the Dissected Drift Plain in Southeastern Nebraska." In this dissertation no attempt was made to present *all* the geography of a selected region, but rather to limit the study to the cultural landscapes within a well-defined natural region. The specific technique was as follows:

1. To observe, describe, and classify the more important cultural features.

---

[1] Jean Brunhes, *Human Geography*. Pp. 16. Translated by T. C. Le Compte. Edited by Isaiah Bowman and Richard E. Dodge. 1920.

[2] P. W. Bryan, *Man's Adaptation of Nature*. Pp. 13. 1933.

[3] R. E. Dickinson and O. J. R. Howarth, *The Making of Geography*. Pp. 245. 1933.

2. To seek explanations for the presence and nature of such features.
3. To make note of such economic and cultural trends as seemed reasonably clear at that time.
4. In a few cases to call attention to possible improvements which might be of benefit to the people concerned.

As is true of most geographic studies, a major portion of this dissertation consisted of description while the explanatory element was relatively brief. Description of cultural features was, however, greatly simplified by the use of numerous photographs and many kinds of maps.

The study just referred to differs from the usual type of *Regional Geography* in that no attempt is made to observe and classify all the geographic features. For instance, such physical factors as land forms, soil, minerals, and climate are discussed only as they give the setting for the cultural features, or as they contribute to a logical explanation of those features. The same is true of such social factors as government, customs, or religion. They are used only in so far as they contribute to a better understanding of the cultural features, and are always of secondary importance.

This method of approach is in some respects similar to various Land Utilization Studies which have been made in many parts of the world. But land utilization studies are often limited to farming areas, whereas the study of cultural landscapes includes all the important works of man, both urban and rural.

The selection of natural or physiographic region in which to study cultural landscapes does not assume that the features studied are distributed uniformly throughout the region; nor are the cultural features limited to that region. The crops common to the region studied may also be found growing in an adjacent region without regard to natural boundaries. The types of homes may extend far beyond the bounds of the region studied. For example, corn and wheat are important crops on all sides of the Dissected Drift Plain in southeastern Nebraska, as well as within that region. The farm homes common there are similar in nearly all parts of the whole Middle West. The study of cultural landscapes within a limited region may therefore be thought of as a sort of cross-section of how man has modified the earth's surface in a much larger territory than is under detailed study.

A political unit such as a county or small state could also serve

as the basis for study, but a natural region will usually have some cultural features which are peculiar to that region. For example, in the Dissected Drift Plain the urban centers and the railways, almost without exception, are located along valleys, while in the Loess Plain to the west these features are commonly located on the flat uplands. It is to be understood that the Dissected Drift Plain discussed here extends several miles into Kansas at the south. This political boundary has no apparent effect on the cultural features.

Any part of the earth where man has been or is today lends itself to the study of cultural landscapes. Regions untouched by man may be of considerable geographic interest, but in a broad sense the more densely populated regions have more cultural features and deserve greater attention than sparsely settled or uninhabited regions. The impartial geographer who wishes to understand man's adaptations as a whole would, therefore, devote most of his time to the great masses of humanity wherever they may be. The valleys and lowlands of southeastern Asia would receive major consideration. These "Farmers for Forty Centuries" have developed a rather static cultural landscape which passes through the same general seasonal changes year after year. The continent of Europe presents a second great concentration of population which the impartial geographer will not neglect. There the cultural landscape presents evidence of several stages of an industrial and commercial civilization which has been superimposed upon a somewhat less static agricultural background than that of Asia. North America will appeal to the impartial geographer, not because of its density of population, but because of its great variety of distinctive cultural features. Here is a land with abundant and varied natural resources and a population which is demonstrating its ability to develop these resources to a high degree.

The same principle of greatest study in regions with the largest number of people may also be applied to studies within the several states or regions of a given country. In general the population is concentrated in the more productive areas. The problems of the densely populated regions are more vital to the state or country than those of marginal regions. Yet there is still prevalent, in this country at least, a general policy of concentrated attention on marginal regions to the disadvantage of really productive areas.

Regional geographic studies, with emphasis on cultural land-

scapes, have much to offer in the solution of local, state, and national problems. An interpretative description of such cultural features as terraces, reservoirs, surfaced highways, communication lines, manufacturing establishments, and playgrounds can be made to serve as a basis for community planning. To the professional geographer this is a fascinating technique of investigation. It is a technique not claimed by specialists in other fields.

AN INTERESTING APPLICATION OF THE ALGEBRAIC METHOD OF BALANCING CHEMICAL EQUATIONS

By Arthur Porges
Lewis Institute, Chicago, Illinois

Although the algebraic method of balancing chemical equations may be familiar to readers of School Science and Mathematics, a brief summary will doubtless aid in the understanding of this application of the process.

To balance a chemical equation, each term is assigned a letter as shown below:

$$\overset{A}{Mo_{12}O_{19}} + \overset{B}{Mn_2O_7} \rightarrow \overset{C}{MnO} + \overset{D}{MoO_3}$$

An equality is then set up for each element in terms of the number of atoms on each side of the equation:

Molybdenum:	$12A=D$
Oxygen:	$19A+7B=C+3D$
Manganese:	$2B=C$

If these equations be solved in terms of any one letter, say A, and that letter assigned the smallest numerical value which will make all the solutions integers, those integers placed in the original order of the letters will balance the chemical equation: $A=A$, $D=12A$, $B=17A/5$, and $C=34A/5$. Let $A=5$. Then we have $A=5$, $B=17$, $C=34$, and $D=60$, and the balanced equation:

$$5Mo_{12}O_{19}+17Mn_2O_7 \rightarrow 34MnO+60MoO_3$$

Ordinarily there is but one mathematical solution of the chemical equalities, and hence but one possible balancing; but

occasionally equations with more than one algebraic solution are encountered. In such cases the algebraic roots may not be chemically correct.

The purpose of this discussion, however, is to call attention to an application of the method which, to my knowledge, has nowhere been mentioned.

If a chemical equation be mistakenly written in such a form that two compounds on opposite sides of the equality sign are interchanged, the error, which may not be obvious from a chemical viewpoint, is easily detected and corrected when algebra has been applied.

Suppose that the equation used earlier as an example had been incorrectly written

$$\overset{A}{MoO_3}+\overset{B}{Mn_2O_7}\rightarrow\overset{C}{MnO}+\overset{D}{Mo_{12}O_{19}}$$

Upon determining the coefficients necessary to balance it, the solver would find that $A=-60$, and $D=-5$. Instead of discarding the equation as incorrect, it is necessary only to transpose those terms algebraically and make them positive, thus obtaining the true chemical equation.

Another incorrect equation is treated in full below.

$$\overset{A}{BaCl_2}+\overset{B}{K_2Cr_2O_7}+\overset{C}{HCl}\rightarrow\overset{D}{BaCrO_4}+\overset{E}{H_2O}+\overset{F}{KCl}$$

Here the chemical equalities are:

Barium:	$A=D$
Chlorine:	$2A+C=F$
Potassium:	$2B=F$
Chromium:	$2B=D$
Oxygen:	$7B=4D+E$
Hydrogen:	$C=2E$

Upon solving these equations in terms of B we obtain: $B=B$, $A=2B$, $C=-2B$, $D=2B$, $E=-B$, $F=2B$. Assigning to B the value 1, coefficients become in order 2, 1, -2, 2, -1, and 2. The *algebraically* balanced equation is then

$$2BaCl_2+K_2Cr_2O_7-2HCl\rightarrow 2BaCrO_4-H_2O+2KCl$$

and upon transposition the correct and balanced chemical equation is obtained:

$$2BaCl_2+K_2Cr_2O_7+H_2O\rightarrow 2BaCrO_4+2KCl+2HCl$$

TWO NEW DAYLIGHT PHOTOMETERS

BY D. L. BARR
Technical Department, W. M. Welch Scientific Company, Chicago, Illinois

Two new photometers of unusual design have been recently developed. One uses two chalk surfaces and totally reflecting prisms to bring the light from the two sources into the same field of view, and the other uses a photoelectric cell in place of the viewing eyepiece.

The exterior appearance of these two photometers are shown in Figs. 1 and 2 below: Fig. 1 is a view of the photoelectric photometer and Fig. 2 is a view of the prism photometer.

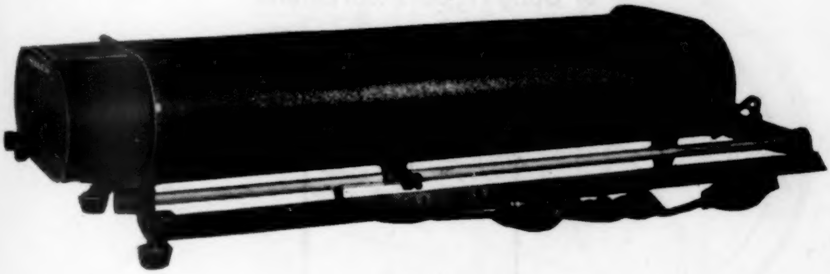


FIG. 1

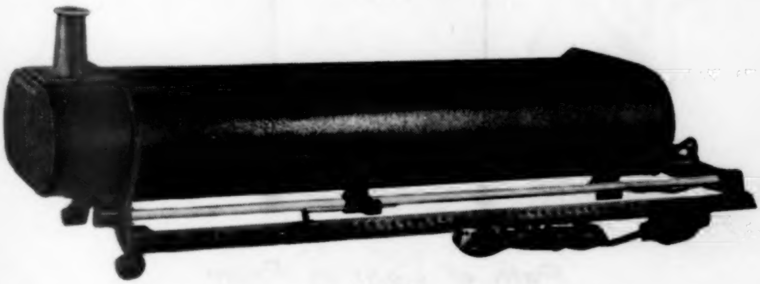


FIG. 2

For many years the photometer has been a clumsy piece of equipment in the laboratory; these two new photometers are an attempt to remedy this situation. One of the factors that has always made the photometer an awkward piece of equipment is the fact that the photometer bed or bench has extended out in opposite directions from the viewing screen. The rather obvious remedy for this inconvenience is to design a photometer in which the two light sources extend out in the *same* instead

of *opposite* directions. The application of the photoelectric cell and reflecting prisms to this problem are explained in the following paragraphs and diagrams.

The main frame of the photometer consists of two tubes in which two electric light bulb sockets slide. The light bulb sockets have attached to them index pointers which refer the position of the bulbs to 60 cm. scales at the sides of the tubes.

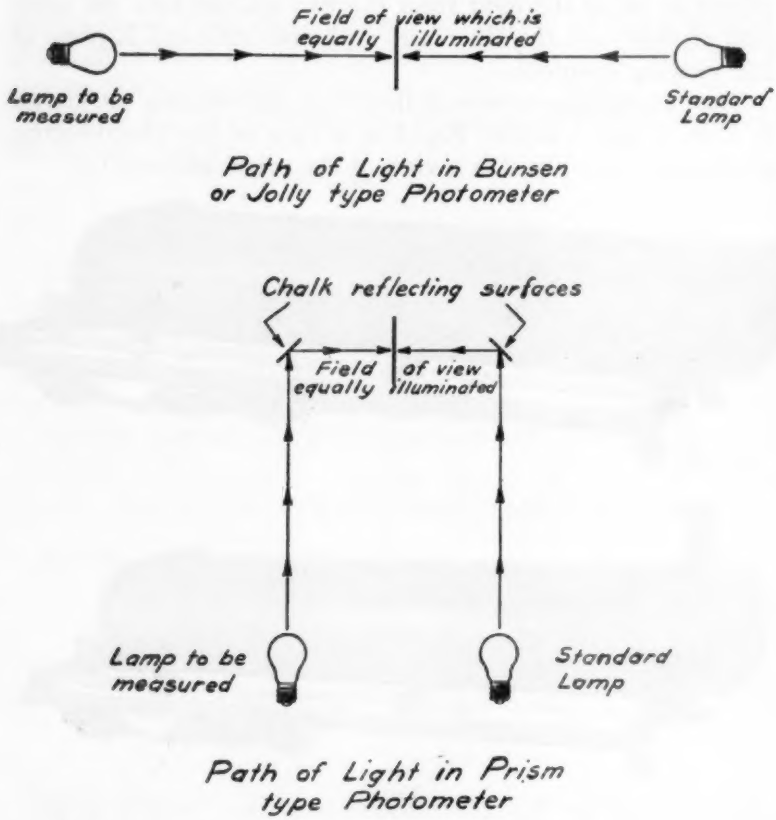


FIG. 3

The meter stick scales have been cut, mounted, and adjusted so that the index pointer will record the total distance from the bulb to the chalk surface or the photoelectric cell.

The path of light in both the conventional photometer and in the new photometer is shown in Fig. 3.

It is apparent that the plan of placing the tubes in the same direction instead of opposite directions has not changed the

principle of photometer measurement and the student should be able to understand the calculations involved in this type of photometer as clearly as in the older types. The convenience of the more compact form will surely be appreciated in the already overcrowded apparatus case.

A perspective drawing of the light path in the prism type photometer is shown in Fig. 4 below.

This view shows how totally reflecting prisms have been employed to bring the light into the viewing tube. When the

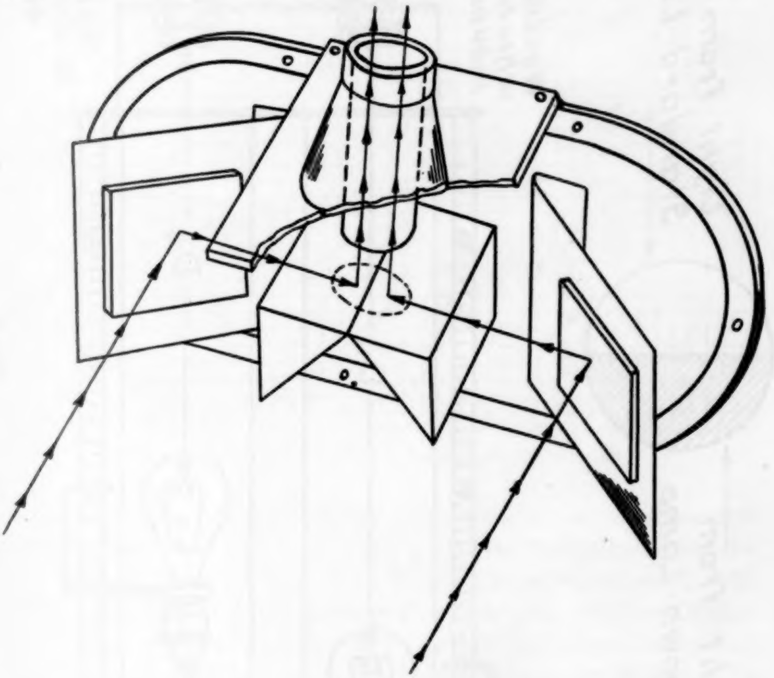


FIG. 4

photometer is unbalanced, or in other words, when the receiving screen is not equally illuminated, one half of the field of view will appear dark and the other half light as shown in Fig. 5.

If the electric light bulbs are adjusted to a distance such that the field is equally illuminated, both half circles will appear equally dark or equally light. Since this method of viewing has brought the viewing patterns so close together that they are viewed by one eye at the same time, it is very easy to obtain an accurate setting. Users of this photometer report a considerable improvement in ease of adjustment over the Bunsen or Jolly

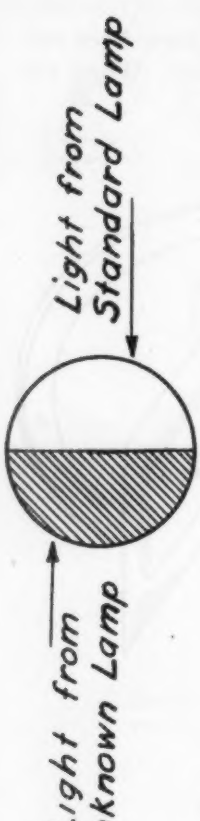

Light from Unknown Lamp
Light from Standard Lamp

Fig. 5

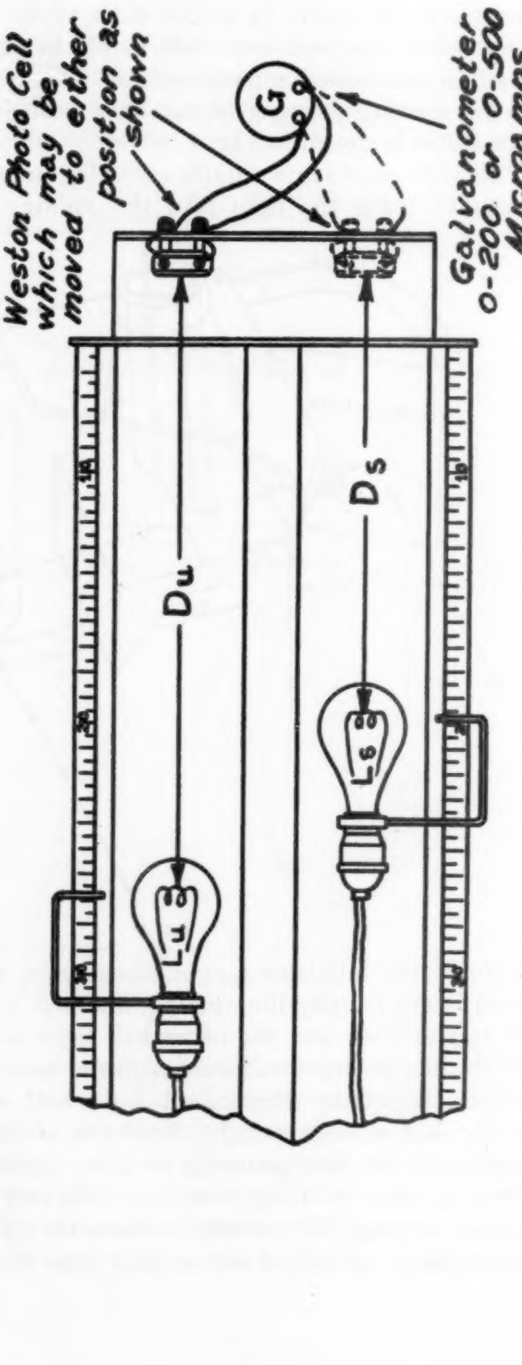

Weston Photo Cell which may be moved to either position as shown
G
Galvanometer 0-200 or 0-500 Microamps
Du
Ds
Lu
Ls

Fig. 6

types of photometers. If one of the light bulbs in the photometer has a known candle power, the candle power of the other bulb may be calculated from the law that the candle powers are directly proportional to the squares of their distances from the screen which is equally illuminated. It will be noted that this photometer measures vertical candle power. Most of our electric light bulbs are mounted in the vertical position overhead and the candle power in this position is the candle power we are interested in.

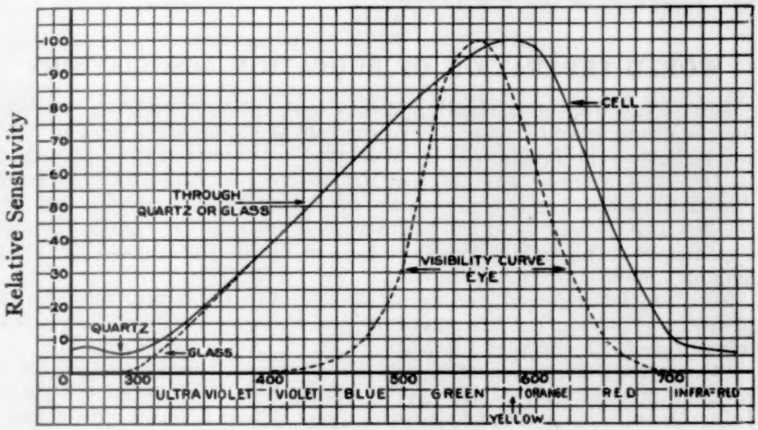


FIG. 7. Spectral sensitivity of the photronic cell.

The photoelectric photometer utilizes the same tubes, electric light bulb sockets and measuring scales but substitutes for the eye, the photoelectric cell. The Weston Photronic Cell is used for this purpose and it is arranged to slide into position so that the light from either the standard lamp or the lamp of unknown candle power may fall upon it. This arrangement is shown in Fig. 6.

It may be mentioned here again that the meter stick scales have been cut, mounted, and adjusted so that the index pointer will record the total distance from the bulb to the photoelectric cell. If a galvanometer or microammeter is connected to the photoelectric cell binding posts the incident light will cause the cell to develop a current since this is the self-generating type of photoelectric cell and the reading of the galvanometer can be recorded. To obtain equal illumination it is only necessary to adjust the distances of the standard lamp and unknown lamp so that equal deflection is obtained on the galvanometer.

This adjustment is exceedingly accurate and will not vary with different individuals since the setting does not depend upon the judgment of the eye as in other types of photometers.

The spectral sensitivity curve of the Weston Cell is shown in Fig. 7, and is seen to approach quite closely to the human eye. If the new Viscor Filter is purchased and placed over the Weston Cell, the spectral response curve of this cell is nearly identical with that of the average eye, and the photometer will then function the same as one set by the eye but not subject to the variation of human vision.

WORLD FEDERATION OF EDUCATION ASSOCIATIONS

Rio de Janeiro, the fascinating beauty spot of South America, combining the charm of old Portugal with the comfort of an ultra modern city, will be host to the Teachers of the World in the summer of 1939, according to Dr. Paul Monroe, President of the World Federation of Education Associations who announced that the official invitation extended through the Brazilian Government has been accepted and that the Eighth Biennial Conference of the W.F.E.A. will be held in Rio during August, the most delightful month of the year in Rio.

Scholarly lectures and stimulating discussions will be interspersed with programs of colorful entertainment, typical of the rich cultural Portuguese inheritance of the people of Brazil.

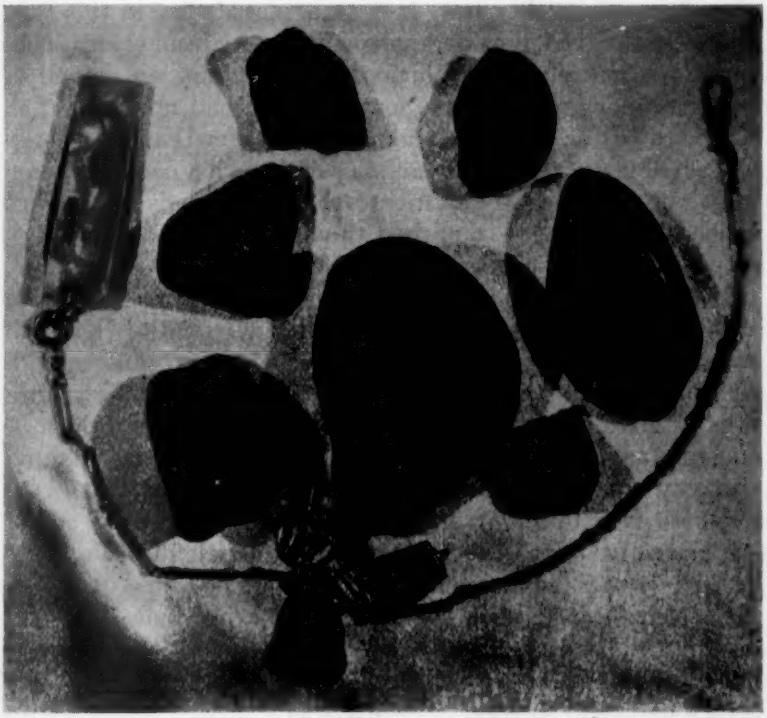
"Our present arrangements," said Dr. Monroe, "comprise two cruises, each of approximately 57 days, sailing from New York about the 1st of July. The minimum fare will be, we expect, about $500.00 with a large number of additional accommodations available at perhaps $600.00. Altogether, the journey to South America with many stops in Central and South America should not prove more expensive than a summer vacation trip to Europe. A great many points of outstanding interest will be visited, and entertainment will be enjoyed in many ports, in addition to the stay at Rio de Janeiro. We believe that the cruise aspect of the arrangement will appeal strongly to everyone. It is further planned to have interesting lecture courses by prominent educators on board ship concerning the countries to be visited. In general, it has been arranged for an expert cruise staff for each ship, which will arrange comprehensive programs of shipboard entertainment and sports, and work out interesting shore trips at the various ports of call.

"Literature and full information regarding these travel plans will be available through the W.F.E.A. Travel Bureau, located in the National Education Association Building, 1201 Sixteenth Street, N.W., Washington, D. C., and also through authorized travel agents throughout the United States and Canada. Everyone interested is urged to write at once to Federation Headquarters, so that adequate transportation arrangements may be made, and the Brazilian Government be informed of the number of guests who may be expected to visit Rio de Janeiro next summer. In view of previous experience in connection with conferences held at Tokyo, Edinburgh, Toronto, Geneva, Dublin and Oxford, we believe that the meeting at Rio de Janeiro will be enthusiastically supported, and that teachers will welcome this unusual opportunity to become better acquainted with our neighbors of South America."

GASTROLITHS FROM THE GIZZARD OF A DINOSAUR

By Edwin Elmore Jacobs
Ashland College, Ashland, Ohio

It is pretty generally well known that the prehistoric animals known as dinosaurs were in reality reptiles but that they were lizards and possessed many of the distinguishing characteristics which our present-day lizards exhibit is not so well known. The word dinosaur literally means terrible lizard and many of them were just that but some were small and inoffensive.



Gastroliths found in Utah

The great assemblage of dinosaurs, which had a world-wide distribution, is divided into two great groups, the division being based upon the structure of the pelvic bones. The group containing the smaller lighter types with hipbones resembling those of birds, is called *Ornithischia* while those known as

Saurischia possessed hipbones similar to present-day lizards. Some of the smaller types having wings took to the air, others developed flippers and took to the water, others, some small, some large, stayed on dry land while still others developed amphibious habits and frequented swamps and shallow water. Many of the latter were of ponderous size and it is quite possible that they relied somewhat on the buoyancy of the water to help them support their enormous hulks.

Everyone is familiar with the type of dinosaur whose likeness appears on certain roadside bill-boards. This is a representative of a very large group some members of which attained colossal size, weighing as much as thirty-five tons and reaching a length of no less than eighty feet. It is to be noted that in this type the neck is curved, long and narrow while the head is also small with jaws entirely disproportionately slight for an animal of such enormous proportions. Some of them had not more than ten teeth to the half-jaw, and were no larger than the stump of a small pencil. Evidently animals with such a poor dentation were not equipped to masticate the 500 pounds of herbage which it is estimated comprised the daily diet and which they cropped from the shores along which they lived.

If this is so, and it is, what is the dinosaur to do? Resort to a gastric mill precisely as our present-day toothless birds do and swallow stones to furnish the grinding substances with which to break up the coarse plant fiber. We find these gastroliths or gizzard-stones scattered about over the area which at one time comprised the feeding range of these dinosaurs and not only scattered about but also in not a few cases in the fossilized remains right at the spot where the gizzard would have been in life. So when these great animals died and were washed down in great river deltas, they were covered over with silt which later hardened into sandstone or shale thus preserving the hard parts of the animal, in some cases not more than a dozen bones being missing. Moreover, specimens have been found lying in what evidently was a natural position with legs and tail fully extended. Found as these stones are, there could be no mistaking them for anything else nor mistaking anything else for them.

The accompanying cut shows a group of these stones, one of which is used as a watchcharm, without further cutting or polishing, so smooth and polished was it by the wear in the gizzard once containing it. All these stones are of quartz, harder

than glass, often flecked with red or yellow, and have thus withstood the ravages of the more than one hundred million years since these animals lay down to their last long sleep. These were found in Utah.

A SUGGESTED METHOD FOR THE TEACHING OF CHEMISTRY TO THE NON-COLLEGE PREPARATORY STUDENT

By Samuel Goodman
Rutgers University, New Brunswick, New Jersey

Perhaps one of the more serious problems that face the chemistry teacher in the secondary school today is, "What shall the course content and method of presentation of the chemistry course to the non-college preparatory student be?" Undoubtedly this has always been present as a "problem" but it is being felt with untoward force and will undoubtedly be felt with greater force in the future. This premise is true because of several factors. Registration in the non-college preparatory course is on the increase. This condition is due to changing labor conditions, changing laws governing the age of departure of the student from the public school system, and the force of economic change; all these have increased the registration and helped alter the character of the pupil in the secondary school from that of a decade ago.

The secondary school ten years ago performed several well-defined functions. It prepared the student for an academic career, it provided commercial training for others, in some instances it attempted to give definite vocational training, and, finally, it provided a general education on the higher level to the pupil who was to emerge into the business world directly from the high school. The student attended school on a voluntary or partially voluntary basis and if he failed to measure up to the mark required of him, he could leave school and be assured of a place in industry.

This is not so today. The forces previously mentioned in the first paragraph, as being responsible for the increase in registration and change of character of the pupils are also responsible for a change in aims. Added to these aforementioned forces should be the limiting of vocational training because of the lack of facilities. All these combined have brought forcibly into

the secondary school the student who formerly graduated from the grammar school into industry, the student who left the secondary school to enter industry, and the student who is no longer acceptable in the vocational school. Let us look at these causes and the pupils forced by them into the secondary school.

The press of economic force and the changing cycle of "prosperity" placed untold numbers into the ranks of the unemployed. This increase in the labor supply inhibited the student who formerly left high school, leaving his studies as he would normally have done before the advent of the depression. The increasingly stringent labor laws no longer permitted the youth to enter industry, at the lower age of graduation from grammar school, so this group continued on into the secondary school. The student who was formerly wont to enter the vocational schools for training in definite vocations or who failed to measure up to the grade of work required in the secondary schools (and thus matriculated into the vocational school) is no longer acceptable in the vocational school on face value. He is forced to compete for entrance with those individuals that cannot afford higher education and are desirous of learning the skills taught in the vocational schools. The vocational school, aware of this situation, accepts the cream of the applicants and returns the rest to the high school to do with as best they can. It is no longer possible for youth, on a large scale, to gain entrance to the trades via the apprenticeship route since the trades themselves are overcrowded by competent but unemployed (wholly or partially) workers.

This new pupil has no academic aspirations and in a large part is not mentally capable of a good grade of work on the secondary level. He is present in the secondary school because he has no other place to go. He is present in theory, to fit himself to enter a business or industrial life under more favorable conditions and at a more advanced age than his prototype did a decade or so ago. What is his curriculum to be? What is he to be taught? Should there be a correlation between his vague future and his academic present? Should he be presented with the same material as his vocational "brother," his commercial "sister," his academic "cousin," or his general "friend"? Or must he have designed for himself a separate and distinct mode of instruction and course content?

The fields of endeavor that the average graduate of the secondary school can enter are quite limited. We may be safe

in predicting that he will enter industry in the main part. In the industrial field he will fall into either one or two phases; to wit, the distributive or the productive. In neither of these two phases is any specific training necessary but rather training of a general nature is necessary. Industry no longer calls for particular skills such as carpentry, painting, plumbing, and the like. Rather it calls for alertness, responsiveness, and an all-around "hand," rather than a specialized hand. This condition, of course, is due to the rapid and completely changing machine world. To present or inculcate some of the above mentioned characteristics in our pupils then must become our aim. We must design our courses in order to accomplish this aim.

The ideal situation would be to predetermine the industry that the pupil would enter and present him with specific information that would be of value to him. This homogeneous grouping with unidirectional aim is impossible; therefore, the course must be designed for the group that is not homogeneous. A consideration of some of the needs of the pupil will help crystallize a conception of the course content and mode of presentation.

There is a definite need on the part of the student (the prospective employee) for a general understanding of what makes his world "go 'round." Industry, as a whole in this country is based pretty liberally on the functions of its chemists. If this is true, then a general overview of the function of chemistry in industry would not be amiss; rather, such knowledge would be of real value. In industry, if our pupil has a grasp on the why and wherefore of the merchandise he is handling, producing, or helping to distribute he takes on added value to his employer. Briefly then, such knowledge will aid him in becoming a more intelligent and capable employee. Finally, it has training value for the future consumer and homemaker. There is a need in the secondary school chemistry for something less academic, less formal, more realistic, and of greater personal value. Obviously, the need here is for an advanced fusion course in the sciences. But chemistry designed as herein suggested can very readily perform this function.

The chemist has made his greatest contribution to industry through his developing appreciation of the quantitative as well as the qualitative appreciation of matter. Chemistry in industry is a mathematical affair and the mathematics is fundamentally of a very simple nature. It is from this angle that we

must approach the instruction of our pupil. The first semester's work should be devoted almost in entirety to a complete basic understanding of the part that chemistry plays in industry and in our daily lives. The stress in this part of the course should be on an understanding of the operation of chemical phenomena. No stress is to be laid on fine theory of atomic structure, valence, formula writing, gas laws, electronic theory, ionization, or oxidation-reduction reactions. The instruction should be basic, matter-of-fact discussion and treatment of established fact.

SUGGESTED OUTLINE OF THE FIRST SEMESTER'S WORK

I. An initiation into another aspect of life.
   A. Chemistry as releated to our daily life.
   B. Chemistry as related to industry.
   C. A brief in favor of the study of chemistry.
   D. What is the world made of?
      1. Solids.
      2. Liquids.
      3. Gases.
   E. What is matter?
      1. Elements.
      2. Compounds.
      3. Mixtures.
   F. Changes (physical and chemical).
      1. What they are and factors involving them.
      2. Relation to life and industry.
      3. Catalysis and catalyzers and their relation to chemical change.

II. A study of some of the elements in the gaseous state.
   A. Oxygen.
      1. Importance.
      2. Discovery and history.
      3. Relation to life.
      4. Commercial uses.
      5. Oxidation (repeat as above).

III. Water, water, everywhere.
   A. Importance.
   B. Use as a solvent.
   C. Use as a standard.
   D. Water.
      1. Hard.
      2. Soft.
      3. Of crystallization.
      4. Chemistry of water.

IV. Air—its composition and behavior.
   A. Importance.
   B. Air—a mixture of gases not a chemically combined compound (compare with solutions).
   C. Composition (discussion of more important components and their behavior).

1. Oxygen (and ozone).
2. Nitrogen (and ammonia).
3. Carbon dioxide (and carbonic acid).
4. Some of the rarer gases and their behavior.

V. Writing of symbols and formulae (on a recognition basis).
A. Touching on atomic structure and combining weights.

VI. Mathematics of chemistry.
A. How proportions are set up with chemical formulae representing reactions so as to be able to determine actual weights involved.
B. Working of problems.
Determining molecular weights.
3. Determining percentage composition.
3. Determining theoretical weights.
4. Determining actual weights.

VII. Acids, bases, salts.
A. Acids.
1. Importance.
2. Classes.
3. Common properties.
4. Some of the more common acids.
B. Bases.
1. Same treatment as for acids.
C. Salts.
1. Same treatment as for acids and bases.
D. The relationships of the bases, acids, and salts.
E. Electrolysis and its importance in industry.

VIII. General review (Tabulation of Knowledge).
A. All unit headings and content tabulated.
(End of First Semester's outline).

Following the first semester's work comes the subject of chemistry as related to industry with a direct application of the knowledge gained thus far where possible.

A SUGGESTED OUTLINE FOR THE SECOND SEMESTER'S WORK

I. A study of colloidal conditions.
A. Colloids defined.
B. Colloids described.
C. Types of colloids.
D. Uses in industry.

II. Ceramic industry.
A. Ceramics defined and its history.
B. Relation to civilization and our standard of life.
C. Pottery.
1. Defined.
2. Materials used (and their specific functions).
a. the clays.
b. feldspar.
c. quartz.
d. calcium carbonate.
e. bone ash.
3. Manufacture of bricks and tile.

4. Manufacture of white pottery.
  a. crockery, china, and porcelain.
D. Manufacture of cement and concrete.

III. Glass Industry.
A. History.
B. Glass, in relation to health, life and civilization.
C. Uses.
D. Materials used in making glass and their special functions.
E. Manufacture of glass.
F. Types of glass and their differences from ordinary glass, example: colored glass or optical glass.

IV. Carbon and its place in the world.
A. Carbon in more than one form.
  1. Crystallized carbon.
    a. diamond.
    b. graphite.
  2. Amorphous carbon.
    a. coal.
    b. charcoal.
    c. coke.
    d. carbon black.
  3. Compounds of carbon.
    a. carbon dioxide.
    b. carbon monoxide.
    c. carbonates.
    d. fuels.
      1. kerosene.
      2. gasoline.
      3. fuel oils.

V. Explosive Industry.
A. History and effect on civilization.
B. Industrial explosives.
C. Military explosives.
D. Some explosives, their history and manufacture.
  1. picric acid.
  2. guncotton.
  3. nitro glycerine.
  4. gunpowder.

VI. Sulfuric Acid (King of chemicals).
"Civilization of a country can be measured by the quantity of sulfuric acid used."
A. Its importance in industry.
B. Comparison with other acids.
C. Chemical properties.
D. Manufacture.

VII. Nitrogen.
A. Importance of nitrogen in compound form.
B. Ammonia.
C. Nitric Acid.
D. Nitrous Oxide.
E. Nitrogen Dioxide.
F. Proteins and Nitrogene fixation.

VIII. Metallurgy makes many things possible.
   A. Dependence of modern life on metallurgy.
   B. Short history of metals of antiquity.
   C. Modern rust-resistant metals.
   D. Factors influencing corrosion.
   E. Corrosion of iron and steel.
   F. Nonferrous metals and alloys.
   G. Copper alloys.
   H. Chromium.
   I. Stainless steels.
   J. Rustless iron.
   K. A dream of the ideal metal.

IX. Automotive industry.
   A. The world of wheels.
   B. Coordination of the metal, paint, rubber, fuel, cloth, and plastics industry makes the automobile possible.
   C. The story of metals in the making of automobiles.
   D. The story of paints in the making of automobiles.
   E. The story of the internal combustion engine.
   F. The story of rubber (as used in automobiles).
   G. The story of plastics (as used in automobiles).

X. Résumé.
   A. Industry and chemistry closely allied.
   B. Coordination and cooperation as influencing factors in life and history.

If the material here is found insufficient (and it may well be), a discussion of the drug industry would not be amiss. Further suggestions as to activities of pupils follow.

I. Current events in industrial chemistry.

One day a week should be aside for discussion of current events digested from daily newspaper and magazine clippings as associated with the material being discussed or to be discussed. This will supply a vast fund of "up to date" information.

II. Two or three field trips to visit industries being discussed.

If these are carefully planned and programmed, they will prove of inestimable value. A visit to a "plant" that has been discussed beforehand with a view as to what is to be seen and looked for; planned "ahead" by the teacher is a valuable source of information and discussion.

III. Term papers of "Projects."

Term papers will help to fix the attention of the student on the industry he is most interested in. The investigations necessary on his part will further determine his decision as to choice of interest and future vocation.

IV. Other student activities suggested are:
   A. Related topics (discussions).
   B. Making exhibits.
   C. Making posters.
   D. Outside reading.

Those localities that have a part of their student body drawn from farm districts would of necessity substitute a complete unit, on the relation of agriculture to chemistry and a further discussion of soils and fertilizers, for any of the units on industry that is deemed superfluous. It should be understood that the subscriber realizes that this is a departure from the conventional methods and that only a trial and error method will determine what is suitable course material and what is not.

The course should be approached at all times from the level of the student's everyday understanding of things and with such an approach he cannot fail to grasp the more rudimentary explanations with the brighter pupils in the class retaining proportionally more. The teacher must needs index the local industries of particular interest to the students and determine what is important and understandable (in the light of their present knowledge) for presentation. Copious demonstrations, of course, are a material aid. The course may serve a dual purpose—as an "educational" course and as a "try out" course in conjunction with a well defined guidance program (since ultimately it will be a guide to local industry).

In its attempts at practical application, the course accomplishes the following ends.

1. It aids in the personal adjustment of the individual to his environment.
2. It leaves the theoretical to come to the level of the student's present day life.
3. It gives him invaluable information of his future job.
4. Where laboratory work is possible, it teaches him a function of good citizenship by associative work with his fellow students or where laboratory work is not possible, it teaches him this function by stress on the necessity for harmony in life and industry.
5. It teaches him to think creatively by examples.
6. It develops new meanings for him.
7. It will develop broad understandings and an ability to approach problems with a definite idea as to method, organization, and the application of principles.
8. It will give him a knowledge of the chemical nature of things and of the importance of chemical change.
9. It will present him with an appreciation of the function and services of chemistry to industry and the well-being of the world.

MUST *ALL* MATHEMATICS BE FORGOT?

BY F. R. POWERS, *Superintendent of Schools*

AND

A. W. ENGLE, *Amherst High School, Amherst, Ohio*

The administrator who has the opportunity to observe the work through all the grades is frequently amazed to find that simple little problems that are easy for the pupils in grades five, six, and seven, are beyond the ken of the pupils in the upper reaches of the high school. Having studied higher mathematics for several years, the upper-classmen fall down on easy arithmetic. Whereupon one hears much about drill and overlearning.

For example, these high school students get all tangled up when they try to add, subtract, multiply, and divide fractions. They seem to have forgotten all about methods of finding areas and volumes. Applying the trial and error method, they bring into play one formula after another hoping always steadfastly for the best. Frequently a whole broadside of accumulated information is fired at some target that looks as though it ought to be in easy range with the result that the mark is missed entirely.

To one who has observed how certain textbooks in bookkeeping succeed in covering up completely any meaning that there may be in very reasonable business transactions it seems quite possible that many arithmetic textbooks make the several operations that can be performed with numbers look more difficult than they really are. Each new problem is taught too much as something wholly different from all its predecessors. It's a new field to be mastered.

Perhaps we can make similarities stand out more than differences. Where there is a common method of approach to a group of problems, it is well to use it and call attention to it as such. It is quite possible to get a pupil to remember what a problem looked like. Probably in your own experience you can recall, even, times when you visualized a certain part of a page in a book as containing some special reference that you wanted to master. You can remember the general appearance of a zebra or of a method of finding a common denominator.

Here are four problems dealing with common fractions.

No. 1. $\frac{1}{2} \times \frac{1}{4} = \frac{1}{8}$

No. 2. $\frac{1}{2}\div\frac{1}{4}=\frac{1}{2}\times\frac{4}{1}=\frac{4}{2}=2$

$$\left.\begin{array}{ll}\text{No. 3.} & \frac{1}{2}+\frac{1}{4}=\frac{2+1}{4}=\frac{3}{4}\\[2ex] \text{No. 4.} & \frac{1}{2}-\frac{1}{4}=\frac{2-1}{4}=\frac{1}{4}\end{array}\right\}\begin{array}{l}2\overline{)\underline{2-4}}\\ \quad 1-2\\[2ex] 2\times1\times2 = 4 = \text{Common Denominator.}\end{array}$$

The first one is the simplest and easiest. The second one is done just like the first after a little complication is taken care of. Consequently they look very much alike. The third and fourth problems look different from the first two and they look very much like each other. The long line with the single denominator is used to make them look different from the first two. The method of finding a common denominator without having to guess it is shown right along with these problems even though it is very easy to see in this case what the denominator is. The next two problems show that addition and subtraction of fractions can be carried almost to completion before we know which of the two processes is to be carried through, just as long as we know that one of the two or a combination of the two is to be the final step. The second of these next two problems brings out the point that any number could be used for a common denominator, although as a matter of common practice we use an easy number to handle.

$$\frac{1}{9}\quad\frac{5}{18}\quad\frac{7}{36}=\frac{4\quad 10\quad 7}{36}=$$

Now suppose the signs are

$$\frac{1}{9}+\frac{5}{18}-\frac{7}{36}$$

Then

$$\frac{1}{9}+\frac{5}{18}-\frac{7}{36}=\frac{4+10-7}{36}=\frac{7}{36}$$

Any number can be used for a common denominator.

$$\frac{3}{8}+\frac{3}{5}=\frac{13\frac{7}{8}+22\frac{1}{5}}{37}=\frac{\frac{1443}{40}}{37}=\frac{1443}{40}\times\frac{1}{37}=\frac{1443}{1480}=\frac{39}{40}$$

But this is easier.

$$\frac{3}{8}+\frac{3}{5}=\frac{15+24}{40}=\frac{39}{40}.$$

The whole history of mathematics is one of finding easy, accurate and reasonable ways of doing things. Don't make the mistake of thinking of the subject as a hard way of solving problems.

Now in addition to trying to fix in mind a picture of these fundamental fraction operations, we need to add a certain amount of ritual or reading of the minutes if we are going to be sure that the information will be available for recall for later use. The mathematical wizard has a way of working out mentally some very difficult problems, getting the right answer although scarcely conscious of any intervening steps between the statement of the problem and the announcing of the answer. The ordinary run of mine pupil reaches the point at which he can safely conclude that four and five added together make nine without having to go back to that kindergarten step which involved the counting of four turkeys and five more turkeys. Some of our high school pupils will no doubt react correctly to the challenge of the problem of multiplying one half by one fourth. But to strengthen the mental picture of the problem these manipulations are added.

Go back to the first problem, $\frac{1}{2}\times\frac{1}{4}$, and call attention to the fact that the multiplication of fractions is the easiest of the operations. Ask the pupil, using the example given, to place the index finger of the left hand on the first numerator and point with the index finger of the other hand to the second numerator, saying, "One times one is one." Now use the same procedure with the denominators, saying, "Two times four are eight." Write the 1 above the line in the answer and the eight below the line. Emphasize the fact that this is the very easiest fraction problem. There is nothing to do but go straight ahead. Incidentally, at this point it is well to call attention to the fact that the answer can be read, one-eighth, one divided by eight, or one over eight. Fractions do not object to being addressed informally.

Take next the division problem, $\frac{1}{2}$ divided by $\frac{1}{4}$, and show that it is exactly like the multiplication problem after the second fraction is turned upside down. Carry the work out in a straight line, using the same method that was used in the preceding problem.

To show why the second fraction is turned upside down, we may draw an example from whole number division in this manner: $12\div 4=3$ let's make the 4 a fraction—4/1, now to get our answer, 3.

$$12\div\frac{4}{1}=3 \quad \text{also} \quad 12\times\frac{1}{4}=3$$

The conclusion we come to is that to divide, we turn the divisor upside down and multiply. Had our 4/1 been 4/2 we would have done it the same way.

$$12\div\frac{4}{2} \quad \text{or} \quad (2)=6$$

$$12\times\frac{2}{4}=6$$

One could show also that if any number is divided by 1, the answer is the same as the number; if any number is divided by more than 1, the answer is less than the number; if any number is divided by less than 1, the answer is more than the number. It is important, however, to show how much alike the first two solutions are, and to call attention to that little difference involved in turning that second fraction upside down.

Next present the addition and subtraction problems as shown in the illustration. Do not say that these are hard, but designate them as the hardest of the fraction problems. Children in the grades about which I am writing have all heard about the common denominator. However, take time to discuss the subject, explaining why we cannot add two fractions without getting first a common denominator. Since the denominator in the adding and subtracting is common, write it only once. My particular reason for presenting adding and subtracting of fractions by this method is to make the two problems look almost exactly alike and to make them both look different from the multiplication and division problems. Carry them out in the straight line method as shown in the examples.

Present early that plan for finding the common denominator and keep it before the house. Show how it is done for the very simple addition and subtraction problem and use it later in the more complicated ones. It is interesting to see a group of older students mill around when faced with a problem in which the denominator cannot be gained easily by inspection. Now about that ritual.

Take the problem, $\frac{1}{2}+\frac{1}{4}=\dfrac{2+1}{4}=\frac{3}{4}$

Find the common denominator, 4, and write it once under the middle of the long line. Have a pupil, demonstrating the prob-

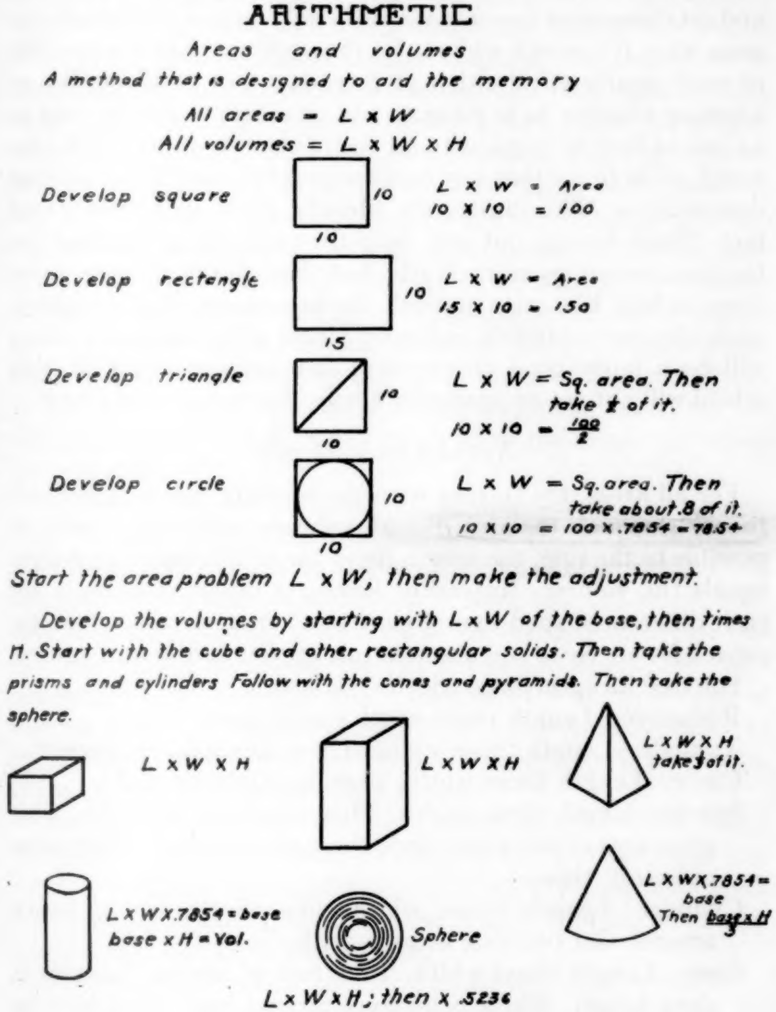


FIG. 1

lem at the blackboard, place the left index finger on the first denominator, 2, and the right index finger on the common denominator, 4, saying, "Two will go into four two times." Now have him move the left finger from the denominator, 2, up to

the first numerator, 1, saying this time, "Two times one are two." Write the two as shown over the long line. Now go to the second of the fractions to be added in the same way. "Four will go into four once." "One times one is one." Write the one above the long line and write in the sign. Add the 2 plus one and get the answer 3 over 4. Work the subtraction problem in the same way. It is worth while to let the pupil see that it is possible to work nearly all of either of these last two problems before knowing whether he is going to add or subtract, just as long as he knows that he is going to do one of the two things. It is also worth while to see that any number could be used for a common denominator. The illustration already given establishes that fact. These devices not only help the pupil to understand the fraction operations more clearly, but they also tie up some more clues to help him later to recall the procedures. With emphasis upon the understanding and upon visual aids to memory, there will be a fairly good chance that the average senior in high school will not get an answer of $\frac{1}{6}$ when he tries to add $\frac{1}{2}$ to $\frac{1}{4}$.

Areas and Volumes

For all areas, try to stay with the formula, the length times the width equals the area. For all volumes, adhere as closely as possible to the rule, the length times the width times the height equals the volume. Instead of having a different formula for each different-shaped figure, have one common method of approach for all. Note how the area rule applies in different figures.

Square—Length times width equals area.

Rectangle—Length times width equals area.

Triangle—Length times width. Then take half the answer.

Circle—Length times width. Then multiply by .7854.

Sphere—length times width. Then multiply by .7854. This gives area of one great circle through the sphere. Take area of four of these.

Cylinder—Length times width. For width, use distance around. Get two base areas as with circle.

Cone—Length times width. Take half of answer. Length is slant height. Width is distance around base. Find base as in circle.

Other solids—Get areas of faces as indicated.

Note that in the triangle, we start not with length times half the height but with the length times the height and then take half of it. In using the formula for the circle, inscribe a circle in a

square. The area of the square is recognized as the length times the width. Start with this same area for the circle. One looking at the figure would readily estimate that the circle is more than half of the square. The number 3.1416 connected with circles is always for some reason easily remembered. One fourth of this number is .7854 which is a little more than $\frac{3}{4}$ and a little less than 8/10. Let's keep in mind that the circle seems to be considerably more than half the square and that there are just three numbers used commonly of the 3.1416 order. Aside from the 3.1416 itself the other two are secured from this same number by dividing by four or by six. One fourth of it produces .7854. One sixth produces .5236. Now since the circle seems considerably more than half of the square, one would estimate that .7854 is the number to be used in getting the area of the circle. By setting up this figure on graph paper and counting the squares, it can be demonstrated that the area comes out as indicated. The same thing can be established by cutting the circle from a square of metal and weighing it. However, the eye studying the careful drawing brings us to the same conclusion quite readily.

It probably is worth the trouble to demonstrate the connection between the distance across a circle and the distance around it. Put a mark on the circumference of a wheel. On a smooth surface such as a table or a floor, run the wheel once around and see how far it traveled in one revolution. Divide this distance by the measured distance across the wheel. The ratio between the two distances will be about 3.1416. If the average of several measured distances is taken, or if the wheel is caused to move along through several revolutions and the average taken, the ratio will be very close to 3.1416.

For finding volumes, take the length times the width, times the height. It might be well to think of this in two steps. The length times the width plus any necessary adjustment gives the area of the base. This times the height with any necessary adjustment then gives the volume.

For rectangular solids, there are no adjustments to make.

Cylinders—Length times width *times .7854* times height.

Pyramids—Length times width times height. Take one third of answer.

Cones—Length times width *times .7854* times height. Take one third of answer.

Sphere—Length times width times height times .5236.

Note that in dealing with the pyramid and the cone, we say length times width times height and then take a third of it. We do not say length times width times one third of the height. With the sphere call attention to the fact that a great deal of a cube must be turned away to cut down to a sphere. It is cut away in all directions. In getting the area of the circle, it is estimated that the circle is considerably more than half of the square and the figure .7854 was used. In estimating the sphere, it will be noted that about half the cube was cut away. That other figure derived from 3.1416 is .5236. .5236 is the figure used in getting the volume of the sphere. By using metal prisms, cylinders and cubes, open at one end and capable of holding water, it is easy to demonstrate that pyramids and cones crowd out about one third of the water contained in the appropriate dishes of same base and height, and that the sphere crowds out a little more than half the water from the cubical dish which it just fits. These measuring devices help the later memory through their making of additional associations. However, the formulas used enable us to start off with a common method of attack instead of trying out all recalled formulas in trying to work a problem in areas and volumes. Particularly in the case of the circle and the sphere, it seems almost impossible to get a pupil to visualize what he is doing when he attempts to get an area or a volume by doing something to the radius.

Square Root and Cube Root

Since not all people have any use for a knowledge of these problems, many of the modern Arithmetic books omit them altogether. Some make a reference to one or both of them in the pages found at the close of the regular content of the book course in Arithmetic. The problems are not hard for the pupil who is "good" in Arithmetic. In fact, they give an incentive for the bright pupil to reach out in mathematics. It is easy to find in Algebra classes in high school pupils working square and cube root problems there, but unable to work a square root or cube root problem in Arithmetic. The Physics teacher finds much of his teaching problem one of computation in Arithmetic.

Present the cube root problem with the use of the blocks. I have found each year pupils who will work a simple problem after the first demonstration of the blocks by the teacher. This demonstration makes an unusually effective appeal to the visual memory. Show carefully that the first large block is the

large cube that can be estimated as part of the final volume. Show that the next blocks are really areas, the length and width of which are the same as the side of the first cube. At this point there comes the first difficult step. The pupil must learn to guess or estimate the thickness of the three blocks. We know the length and the width. We know also the length of the next three blocks in the set. Our estimate of the thickness of the first three will be used as the width of these three. There is one small cubical block left to fill out the built up set. We can see that the length and width of this block also are the same as the estimate that we have made of the thickness of the first three blocks. Show that the first number in the answer is cubed to produce the large cubical block and that the succeeding numbers in the

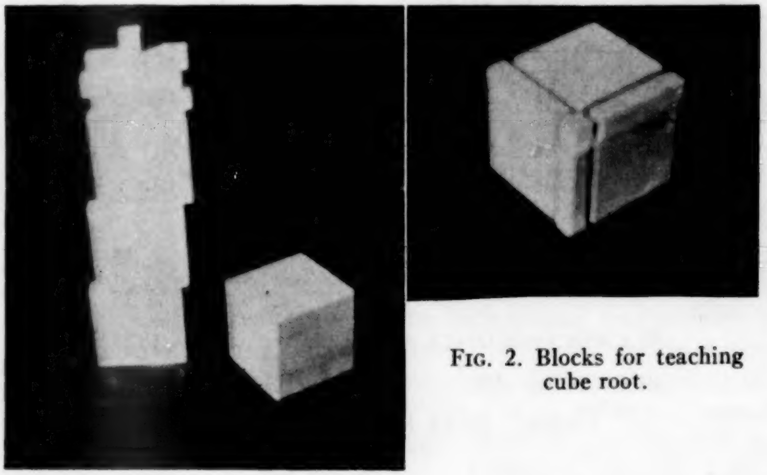


FIG. 2. Blocks for teaching cube root.

answer are really the thickness of the added blocks. When we multiply the last number in the answer by the number that we have built up over at the left, we are really multiplying the area by the thickness to get a volume. This can easily be shown by spreading all the added blocks out in a row and noting that the figures built up are really the combined areas of these added blocks.

There is no attempt here to give a complete demonstration of cube root, but rather to point out certain features to which particular attention should be given. In order to help the pupil remember that Cube Root problems are pointed off in sets of three numbers and Square Root in sets of two, call attention to

the fact that nine, the largest digit, squared produces 81, a number of two places. Show that 9 cubed produces 729, a number of three places.

In dealing with Square Root and Cube Root, advise the pupil who has not recently worked a problem to build up a problem of his own in easy figures and work it backwards. For example, if one is not just sure about his square root method, let him square such a number as 25 and then extract the square root, knowing that the answer should be 25. Then let him turn to his problem with the same method. There is probably available no demonstration method that will add much to show just why

SQUARE ROOT

$$
\begin{array}{r|l}
 & \overline{12}\ \overline{25})\underline{35} \\
 & 9 \\
65 & 3\ 25 \\
 & \underline{3\ 25}
\end{array}
\qquad\qquad
\begin{array}{r}
35 \\
\underline{35} \\
175 \\
\underline{105} \\
1225
\end{array}
$$

CUBE ROOT

$$
\begin{array}{r|l}
 & \overline{42}\ \overline{875})\underline{35} \\
 & 27 \\
30\times30\times3=2700 & 15\ 875 \\
30\times\ 5\times3=\ 450 & \\
5\times5=\ \underline{25} & \underline{15\ 875} \\
3175 &
\end{array}
\qquad\qquad
\begin{array}{r}
35 \\
\underline{35} \\
1225 \\
\underline{35} \\
6125 \\
\underline{3675} \\
42875
\end{array}
$$

Square Root is done as it is. It is probably easier simply to find the best way of following the necessary directions. Using the note already given, show that the problem is pointed off in places of two numbers. Take the largest square that will be contained in the first place to the left. Subtract, bring down the next two numbers, and for your trial divisor, *double whatever there is in the answer*. Then bear in mind that whatever is written next in the answer is also to be added at the end of the number in the trial divisor before multiplying across. I have found sixth grade students working square root problems of a simple order before the close of a 45 minute period in which the plan was first

presented. Of course, no large proportion of the class will get the method located so quickly, nor will those who do get it have it definitely learned at the close of one 45 minute period.

A square root and a cube root problem are submitted on the preceding page.

The Triangle with Three Sides Given

Probably the triangle most often found to be worked outside of school is the one in which the three sides are given. The solution of this case is interesting for the good upper grade student. In this formula, s stands for semiperimeter. *A*, *b*, and *c* are the three sides. It doesn't make any difference which side is *a*, *b* or *c*, just so all three of the sides are used.

This is a special case, recognized as such when we present it and easy of solution.

$$\text{Area} = \sqrt{(S(s-a)(s-B)(s-c)}$$

Suppose *a* equals 6, *b* equals 8, and *c* equals 10. Then perimeter is 24 and semiperimeter is 12.

$$\sqrt{12(12-6)(12-8)(12-10)}$$
$$\sqrt{12(6)(4)(2)}$$
$$\sqrt{576} = 24 = \text{Area.}$$

As pupils progress through the high school, particularly in the mathematics and science courses, review the material herewith presented, using the methods given. A few minutes at frequent intervals will accomplish more than extensive periods widely scattered in point of time. Do not assume that the courses covered in the upper grades of the elementary school will be mastered there for all time.

Problems of Physics

In the chapter on Work and Mechanical Energy may be found many formulas. I shall list a few.

$$E \times s = R \times s' \qquad R/E = N \qquad El = Rl' \qquad Es = Rs'$$

$$R/E = 1/h \qquad R/E = \frac{2\pi l}{d} \qquad R/E = \frac{2\pi ln}{2\pi r}$$

This multiplicity of laws, or rather of formulas, is confusing. The pupil should be shown that the general law is that $F \times d = f \times D$. Or, in other words, the greater force times the smaller

distance equals the smaller force times the greater distance. Any of these problems whether they deal with the inclined plane, sets of pulleys, jack screws, windlasses or trains of gear wheels, can be worked by the one formula. There is no need of knowing about any other or trying to remember any other.

Just to illustrate, suppose there is a two-foot lever on a jack screw and that the screw has a thread of $\frac{1}{4}$ inch. A two-foot lever moving once around would pass through a circle with a diameter of 4 feet. Going around once would pass the end of the lever, where the force is applied, through a distance of 4 times 3.1416 or 12.5664 feet. This would be 150.7968 inches. While the force was going through the distance just found, the load moved up only one thread or $\frac{1}{4}$ of one inch. Thus, disregarding friction, a small force of 1 pound moving through 150.8 inches would be equal to a load of 603.2 pounds moving $\frac{1}{4}$ of one inch.

$$F \times d = f \times D$$

$$603.2 \times \tfrac{1}{4} = 1 \times 150.8.$$

Whatever we can do to simplify the approach to problems and to aid in recall of method will result in less forgetting of needed mathematical skills in the upper reaches of our high schools and colleges. Mathematics should be taught as the easy way to solve problems. If more time were given to the history of the subject and to the story of the folks who have made these solutions available for us, it is quite possible that the content would linger more easily with the appreciative student.

There is one special problem that might require a little additional information. I refer to the one in which the weight of a pole such as a telegraph pole is determined first by balancing the pole on a fulcrum, then placing a known weight on one end of the pole and shifting the pole on the fulcrum until the pole balances again. In this case the known force times the distance to the fulcrum in use when the pole balances with the known force applied is equal to the weight of the pole times the distance the fulcrum is shifted from the balance with no weight added to the pole to the balance when the known weight is added. This, however, is practically force times distance equals Force times Distance.

We have found that by using the area and fraction suggestions given, the suggestions about square and cube root, and this general work formula, many of the mathematical difficulties of the Physics course are simplified or removed.

Problems of Chemistry

After one has learned to read the molecular weight tables, the percentage of composition problems should not be difficult. For example a molecule of water weighs 18.016. It contains one oxygen atom of weight 16. The problem is to find what per cent of the molecule is oxygen. It is 16/18.016 or 88.81%.

While this problem looks to be very simple, some of the pupils will require many repetitions of the use of the method before they have mastered it. Some master it at once.

The following problem is not so simple.—I wish to prepare 100 grams of oxygen using potassium chlorate as a source of oxygen. How many grams of the chlorate will be required?

$$\begin{array}{lr} 2KClO_3 \text{ produces } 2KCl \text{ plus } & 3O_2 \\ 245.12 & 96 \end{array}$$

Proportion:—245.12:96:X:100; or X equals 255.33 grams.

The formula looks easy, or rather the proportion method of working the problem. The difficulty lies in the fact that many of the pupils will not see what it is all about. Here is what we must show—

The oxygen over at the right is the same oxygen that was over at the left. It weighs the same. The six atoms at the right weigh 96. The six atoms at the left weigh 96.

The whole molecule at the left weighs 245.15. Consequently the oxygen in this molecule is 96/245.12 or 39.16% of the molecule. This 39.16% of the molecule weighs 100 grams divided by 39.16%. That gives us the answer 255.33 grams.

Part of the problems should be worked without using the proportion at all to make clear to the pupil the percentage of composition is the important consideration.

Equations

Equations are often stumbling blocks to students of chemistry and physics. It seems that equations are taught as diversified types. They should be unified.

The word "equals" by itself is well understood by the student, but when it occurs in an equation, its meaning is often lost. When the grocer weighs out a pound of sugar for you, he puts a pound weight on one side of his balance and pours the sugar into a sack on the other side until the balance pointer is at zero,

i.e., he makes the weight of the sugar equal the weight of the pound weight. He then has a balanced equation—1 lb. = 1 lb. The one big principle in working equations is this: what you do to one side of the equation you must do also to the other side. The golden rule for solving equations might be stated in this way: Do unto one side of the equation as you would do unto the other side.

Let's take a simple equation with the unknown X such as $X+15=25$. Find the value of X. On one side of the equation we have $X+15$ and on the other side we have 25. If we could take away the 15 we would have $X=25$ and our equation would be solved. But this would be breaking the golden rule. If we take 15 from one side we must take it from the other side too. Thus:

$$\begin{array}{rr} X+15= & 25 \\ -15 & -15 \\ \hline X+\ 0= & 10 \end{array}$$

Or, if the case demands, we may add the same number to both sides. Thus:

$$\begin{array}{rr} X-15= & 25 \\ +15 & +15 \\ \hline X\quad = & 40 \end{array}$$

We can add or subtract the same number to or from both sides. Applying our golden rule to another simple equation:

$$5X=25$$

Here we have $5X$ on the left side of our equation. We want only X. We can change $5X$ to $1X$ by dividing $5X$ by 5:

$$\frac{5X}{5}=X$$

We have divided the left side by 5, so we must divide the right side by 5. Our equation will then look like this:

$$\frac{5X}{5}=\frac{25}{5}$$

And we get $X=5$.

An equation where we multiply both sides of the equation by the same number looks like this:

$$\frac{X}{3}=5$$

Our job here is to make the 3 in the denominator equal to one: $3 \div 3 = 1$. If we multiply $X/3$ by 3 we have $3X/3$ and, of course, $3X/3$ is equal to X—which we wish to find. We must now multiply the other side of our equation by 3—

$$\frac{3 \cdot X}{3}=5 \cdot 3$$

and $$X=15.$$

Remember that the equals mark in the equation is a guarantee that both sides of the equation will get a square deal.

To sum up:

1. If a number is added to or subtracted from one side the same number must be added to or subtracted from the other side.

2. If one side is multiplied or divided by a number, the other side must be multiplied or divided by the same number.

A few more illustrations:

Problem	Solution
(1) $X+9=20$	$\begin{array}{rcr} X+9 & = & 20 \\ -9 & & -9 \\ \hline X & = & 11 \end{array}$
(2) $X-9=20$	$\begin{array}{rcr} X-9 & = & 20 \\ +9 & & +9 \\ \hline X & = & 29 \end{array}$
(3) $3X+9=20$	$\begin{array}{rcr} 3X+9 & = & 20 \\ -9 & & -9 \\ \hline \frac{3X}{3} & = & \frac{11}{3} \\ X & = & \frac{11}{3} \end{array}$
(4) $\frac{X}{4}=8$	$\frac{4 \cdot X}{4}=8 \cdot 4$ $X=32$

(5) $\frac{3X}{4}=8$

$$4\cdot\frac{3X}{4}=8\cdot 4$$

$$\frac{3X}{3}=\frac{32}{3}$$

$$X=10\tfrac{2}{3}$$

Thermometry

The physics or chemistry teacher finds, as a rule, that the students are unable to change Centigrade temperature readings to Fahrenheit ones and vice versa. A period of a few years has elapsed since they were drilled in the appropriate formulae back in the General Science Class. Even teachers will admit that they often check up on these two formulas before teaching them to the class. We have had more success from the process method of teaching than from the formula method.

The process method:

Facts:

212°F. equals 100°C.

32°F. equals 0°C.

180°F. (Degrees between 32° and 212°) equals 100°C. (Degrees between 0° and 100°C.)

$$\frac{180°\text{F.}}{180°}=\frac{100°\text{C.}}{180°} \text{ (An equation)}$$

$$1°\text{F.}=\frac{5°\text{C.}}{9}$$

And

$$\frac{100°\text{C.}}{100}=\frac{180°\text{F.}}{100}$$

$$1°\text{C.}=\frac{9°\text{F.}}{5}$$

Problem:

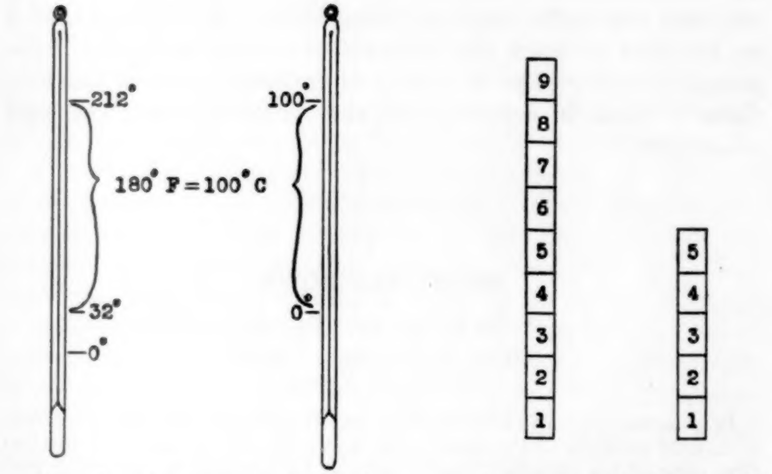
Change 10°C. to F°.

$$1°\text{C. equals } \frac{9°}{5}\text{ F.}$$

10°C equals $10 \times \frac{9°\text{F}}{5}$ equals 18°F. On the Fahrenheit

scale we already have 32° more than the Centigrade scale has to start with, so we add our 18° to them—18° plus 32° equals 50°F.

Problem: Change 50°F. to C°.



Note that the mercury rises and falls through the same distance whichever thermometer is used.

Comparison of 1°C. to 1°F. When 1°C. = 9/9, 1°F. = 5/9 When 1°F. = 5/5, 1°C. = 9/5

FIG. 3. The Fahrenheit and Centigrade scales.

Our Centigrade scale starts at zero and the Fahrenheit scale starts at 32°. To balance this, we must subtract 32° from our 50°.

$$50°\text{F.} - 32°\text{F.} = 18°\text{F.}$$

$$1°\text{F.} = \frac{5°\text{C.}}{9}$$

$$18°\text{F.} = 18 \times \frac{5}{9} = 10°\text{C.}$$

We do not mention formulae at all.

Recall

Ability to recall probably depends to a great extent on psychological influences during training, such as motivation and mental abilities and physiological ones such as hearing, seeing, and glandular defects in each particular student. Our con-

tention is that the bases of recall are, (1) a thorough understanding of processes—not just a knowledge of their routine; (2) similarities standing out more than differences; (3) new processes learned in terms of old familiar ones where possible. The whole history of mathematics is one of finding easy, accurate and reasonable ways of doing things. We believe that if we are able to teach our students to understand a few basic processes rather than a jumble of formulas, we are teaching them to think in mathematics, then recall becomes the least of our worries.

NIGHT RAINBOWS

By M. Anthony Payne
Mount St. Scholastica College
Atchinson, Kansas

In a recent issue of *Science*,[1] Professor Lobeck records the occurrence of a night rainbow in the trade wind belt and calls attention to the fact that none of his scientific friends seem to have witnessed a similar phenomenon.

A colleague of mine, who taught in Steinaur, Nebraska, during the Spring of 1924, saw a perfect rainbow in the skies early one April night. A few details may be of general interest since Steinaur is in the western section of the Central States, inland and relatively far north, while Miami is just a few degrees north of the Tropic of Cancer.

My friend states that it was a wet season and had rained nearly all that particular afternoon. About nine o'clock in the evening she went to close the windows and behled a perfect rainbow in the north west corner of the heavens. The sky was full of storm clouds and a full moon was riding high in an open space toward the south. Later the moon went under a cloud and the rainbow disappeared.

"The rainbow was large and extended across the sky. It was as bright as any that you see in the day time, and as I remember, a secondary rainbow could be distinguished, but it was much dimmer," she said.

When questioned as regards the relationship of the primary and secondary rainbow and the width of the bands, she was not certain, but assured me that she was positive about the brightness and size of the primary rainbow because its appearance at night had been so surprising.

Authorities state that rainbows can "be formed by moonlight."[2] The one in the Nebraska sky was very distinct and probably had a secondary rainbow associated with it.

Since these phenomena depend in a marked way on the size of the drops in the clouds and on the locus of the light,[3] there seems to be no reason why more night rainbows should not be recorded as time goes on.

---

[1] Lobeck, A. K. 1938. A Rainbow at Night. *Science*, vol. 88, No. 2278, p. 187.
[2] 14th Edition *Encycl. Britannica* 1932. Rainbow. vol. 18., p. 954.
[3] Wood, R. W. 1934 *Physical Optics*. Macmillan p. 392.

A PARENT NIGHT PROGRAM

By R. W. Woline
Community High School, Gillespie, Illinois

I'm sure that practically all school systems have had an "Open House," a "Parent's Night," a "Dad's Day," a "Mother's Day" or some other event similar in nature. I would like to present an explanation of a "Parent's Night" which was held in our Community High School at Gillespie, Illinois.

The Faculty decided to hold a "Parent's Night" to which all of the parents of our students should be invited. The students were not allowed to be present unless they had a part in the program. Each parent was to be given a copy of his or her child's schedule. They were expected to take the student's place and actually go through the student's daily routine. We have a six-period day, with hour periods. The periods were shortened to fifteen minutes. Each instructor was to use this fifteen-minute period as he saw fit. Most of the instructors attempted to explain the value of his particular course and also the different things he tried to teach in his course.

We feel that this "Parent's Night" was very successful and that we accomplished our aim, namely, better acquaintanceship between parent and teacher and to give the parent an idea of what we in the school are trying to do and how we try to do it.

The balance of this paper will deal with the program that was carried out by the Physical Science Department.

I wanted to speak to the parents about our work in the department and also wanted to show them some of the laboratory work too. Since this was impossible in the time allotted per class period I decided to prepare a booklet explaining the department in some detail and to have various students perform some of the different experiments which we do in the laboratory.

Each student was given definite typewritten instructions as to what he was expected to do. A chart was made of the laboratory and each student was assigned a definite place at which to perform his part of the program. The students had a week in which to prepare their material. The students took hold very well and cooperated to the best of their ability. (I might add here that some of the students were rather dubious about our success, and so was I, but they worked hard and we all feel that the program was very successful.) There was not a single student who failed

to have his part ready although there were a few students who did not care to take part. It was a very easy matter to find students who were very anxious to take the place of these indifferent students.

The parents were met at the door by a guide who gave each parent a "Science Department Booklet" and who directed them to the classroom. Here I explained the purpose of the booklet, touched on a few highlights of my work and explained what was going on in the laboratory. This took about five minutes. Then the parents passed to the laboratory where they inspected and watched some of the demonstrations.

All of the experiments were going on simultaneously. This led to a certain degree of confusion and noise but I checked up to see if this was a serious fault and I found that it was not. Due to the number of demonstrations it was impossible for each parent to see every demonstration but they did see a goodly number of them and did talk with many of the students. The program and three of the student talks follow.

THE PROGRAM

Talk	Mr. Woline
Grade and High School Science Program	Mr. Renner
Guide	Mary Jane Hill
Reading Table	Evelyn Monke
Anti-freeze Testers	Bob Milner
Hydrogen	Bob Eilers
We Study General Science	Florence Russell
We Study Chemistry	Roberta Lambie
We Study Physics	Maurice Rich
Distillation of Water	Junior Hertig
Colored Flares	Tom Edwards
Ammonia Fountain and Pile Driver	Howard Hoehn
Laws of Floating Bodies	John Russell
Wooden Hydrometers	Bill Hill
Bunsen Burners Club	Orval Hailstone
Active Atoms Club	Bud Kiss
Play After School	Dwight Lewis
Electricity	Jack Rice
The Dispensing Room	Ida Mae Graham
Library and Record Keeping	Pearl Dement
The Secretary's Duties	Marjorie Wilcox
The Science Department	Fred Main
Test Analysis Sheets	Rolland Hoehn, Jr.
Newspaper Clippings	Rugh Curot
Projects	Mary Portugal
Carbon Dioxide	Richard Johnson
Oxygen	Viola Cox

DEMONSTRATION OF HYDROGEN

By Bob Eilers

In the bottle on the shelf is dilute hydrochloric acid. When the stopcock is released, this allows the acid to run down the tube by the siphon principle into this bottle which is called the gas generator. In it are a few pieces of zinc with which the acid reacts to form the hydrogen. The pressure created in the generator forces the hydrogen through the glass tube into the pneumatic trough which is filled with water. Hydrogen can be collected by displacing water, because it is practically insoluble. Hydrogen burns in the presence of air, and when it is ignited it burns quietly down the test tube. This time we shall use only a half tube of hydrogen, and the rest, air. Now when it is ignited, a sharp bark is heard. This is the explosion caused by the mixture of hydrogen and air. When hydrogen burns in the presence of oxygen, water is formed. This is not noticeable inside the tube because the tube got wet when the hydrogen was collected by the displacement of water. Hydrogen is not prepared commercially in this manner because it is far too expensive. Water gas is used. This is made by passing steam over heated carbon. This forms two products, hydrogen and carbon monoxide. A certain chemical process is used to separate the carbon monoxide from the hydrogen. Hydrogen, by itself, will not burn, but when mixed with air is very explosive. It is used in dirigibles, balloons, etc., and in hydrogenation. This is a process by which hydrogen is mixed with certain waste oils to form usable solids such as lard, crisco, spry, etc.

HOW WE STUDY GENERAL SCIENCE

By Florence Russell

The two main books used in studying General Science are our textbook *Everyday Problems in Science* written by Charles John Pieper and Wilbur Lee Beauchamp and our workbook written by Beauchamp and Harold H. Miller. Our textbook and workbook both are divided into seventeen units and each unit has a certain number of problems.

In addition to our two main books we have many good reference books pertaining to physics, chemistry and other sciences. These are available to us any time we want them during class, but if we want to take them home or use them outside of class we have to get permission from our teacher or librarian.

Every so often the teacher either collects our books or comes around to each student to correct his workbook. Each exercise that is correct he checks. As he checks the exercise off we put it on the report, on the bulletin board, so the other students and teacher may tell how far we have progressed.

THE LAW OF FLOATING BODIES

By John Russell

This set up shows why ships float and why they sink. When a ship goes into the ocean as it pushes downward it pushes from under it a certain amount of water. We say it displaces a certain amount. What causes this displacement, and how much, is determined by the volume and weight of the vessel. The more volume and weight, the more water it pushes away. This "pushed away" water, as we call it, is what holds the ship afloat or we say it is the buoyant force which floats it. If the ship gets a leak and fills up, the weight of the ship becomes too great for the volume of the ship to displace enough water to hold the excess weight up, therefore the ship goes down. It goes to the bottom.

A STUDY ON IMPROVING LABORATORY EFFECTIVENESS

By Thurman M. Huebner
Bowen High School, Chicago, Illinois

Physics, the exact science upon which our industrial order is based and physics, the homely everyday science intimately associated with the lives of all, stands on trial today as an efficient tool in introducing habits of scientific thinking, initiative and mechanical resourcefulness to the democratic majority now forced through our school curriculum. Our laboratory work especially, must be approached by the pupils with interest, initiated and planned with purpose, and reported in a manner that does not destroy, but instead heightens the joy of successful doing and understanding.

Various techniques are used in attempting the best job possible and many studies have been made such as those comparing the demonstration method with individual laboratory work and "even front" with rotational systems. In spite of this wealth of research evidence available, many teachers still continue to go along in their time honored patterns more firmly intrenched than ever, perhaps, in some personal fetish with respect to laboratory work, as for instance, the belief that thirty physics pupils can do a supremely better job if rushed through thirty simultaneous laboratory executions of the same experiment with duplicate apparatus and then write up thirty formal laboratory reports by filling in the blank spaces in identical manual sheets. The final convincing argument is that these thirty reports give the pupils uniform experience in writing neatly in ink and tabular form scientifically organized material that can be checked in the last two minutes of the period.

In the present day trial of physics, the jury is formed of the pupils themselves, and success depends in large part upon the selection of the proper technique in administering the laboratory work and checking results to insure appreciation and understanding. Even though we might not look favorably upon the lock step methods described in the previous paragraph but instead are inclined to agree with Duel[1] who advocated the rotational system, nevertheless laboratory work must be checked

[1] H. W. Duel, "The Even Front System versus the Rotation System in Laboratory Physics." *School Review*, XXVI (June, 1928).

and the question of the most efficient method is vitally important.

During one year, a teacher must usually examine upwards of 12,000 experiment reports (over two miles) and if the eternal vigilance is slackened for a moment, evidences of dishonesty, disinterest and mediocrity are soon forthcoming. One questions if this paper work in the laboratory is not more of a development of secretarial skill than the scientific thinking we are trying to foster. Dr. W. L. Beauchamp makes a rather amusing parenthetic qualification of his general criticism of the formal busy-work write-up method in common vogue when he says:

. . . In some schools, the laboratory is considered as a source of data for the solution of problems[2] . . .

Following up the thought of this statement, one is led to examine more closely, in the interests of improved effectiveness of laboratory work, the two areas suggested, namely, (1) checking techniques and, (2) types of experimental problems.

Our attention, at Bowen High School, Chicago, was first turned to an examination of our checking techniques due to our limited and partial success attained from our laboratory efforts involving the formal recording of experiments and the many hours spent therewith. We decided to make a comparative study to determine the worth of formal recording in contrast with testing. Our question was, did this formal recording of experiments contribute to the understanding, or could we omit it entirely and administer a test instead, thereby directing the thinking to the pertinent concepts involved, insuring effectiveness and saving time. It was decided to compare the scores made on final examinations of a group of pupils who solved experimental problems and reported them in the formal manner with the scores of another contrasting group who worked the same experiments and did not turn in any report but simply took a short, quick test to determine if they had obtained adequate results. The two methods of reporting then might be referred to as the "formal" and "test" methods. Like most studies of this sort, it involved problems in administration and a great deal of detailed labor, but to those who participated in it the results have been found significant and are being incorporated in our present technique.

The first test, a matched pair study involving twenty-nine

[2] W. L. Beauchamp, *Instruction in Science*, p. 51, United States Department of the Interior Bulletin No. 17, Monograph No. 22. Washington: Government Printing Office, 1932.

selected pupils in one set of classes, whose I.Q., chronological age and previous physics grades were as nearly as possible equal to those of an equal number of pupils selected from a different pair of classes, indicated that those pupils who reported experiments by the test method made greater gains than those who reported by the formal method. The advantage, however, was not considered to be sufficiently significant to be conclusive and therefore a more accurate method of balancing out individual differences was adopted according to the rotational technique described by McCall.[3] Four classes were studied which were of equal size and which met during the morning hours. They had the following period arrangement:

First Period, Group A, Pupils 1 to 24
Third Period, Group B, Pupils 1 to 24
Fourth Period, Group A, Pupils 25 to 48
Sixth Period, Group B, Pupils 25 to 48

The first period "A" class was assigned a series of four experiments to work out individually during a period of three weeks and report by the formal method. The same work was assigned the fourth period "A" class, but they were introduced to the test method and advised to report by taking a short, typewritten test immediately upon completing the work of an experiment. Likewise, the third period "B" class worked on a series of four "B" experiments for three weeks and reported by the formal method while the sixth period "B" class did the same work by the test method. At the end of the three week period, an examination, made up of general questions about the experiments worked, was administered to the "A" and "B" groups. During the next three weeks, each class rotated its method of reporting and continued with another series of four experiments after which a second set of comprehensive examinations was administered. Thus, each pupil was exposed to each method and the effect of the more energetic classes was balanced out. This was found to be an essential consideration inasmuch as our laboratory work always followed the plan which we believe to make for the most individual freedom and show of initiative, the plan of allowing the pupils to work any experiment and in any order they found most convenient due to equipment limitations and special interests.

[3] William A. McCall, *How to Experiment in Education*, pp. 162 and 193, New York: Macmillan Co., 1923.

Omitting the details of calculations, given elsewhere,[4] necessary to isolate the experimental factor, it was found that the matched pair study as well as the rotational study showed a net gain in the scores of those who reported by the test method. The matched pair pupils in the test method work had comprehensive examination score gains averaging 7.02% higher than those who made the carefully drawn reports. The rotational study gave the test method an advantage in the combined score average, after six weeks, of 11.85%. The statistical ramifications give more significance to this latter comparison. The experimental coefficient obtained, namely, .68, indicates chances of 34 to one in favor of better comprehensive examination grades after reporting experiments by the test method instead of by the formal method.

Further study of the comprehensive examination grades showed conclusively that if Pupil 1, for instance, had "done" Experiment 47 and had not "done" Experiment 48 he could answer general questions about the former but not about the latter. Correlations were calculated and it was found that the "doing" of an experiment in the laboratory and the success therewith on examination shows a coefficient of correlation as high as $.660 \pm .09$, which indicates that individual laboratory work is useful in teaching the principles of physics involved.

Turning now to the second phase studied for the improvement of the effectiveness of our laboratory work, namely, types of experimental problems, we met with the question of completely reorganizing our course material. With our student body, made up largely of pupils of foreign extraction, the following of written instructions was at best troublesome, and the use of manuals dedicated to college preparatory experiments was of course out of the question. It was also the consensus of opinion of the three cooperating teachers that a wealth of newer, simpler experiments of the problem type could be prepared better to correlate with life interests. Such a series of problem questions was finally worked out and mimeographed for the pupils. The aim was toward a more homespun type of experimental thinking and practice following the methods of science in the use of equipment and the gathering of ideas. Each of these problem questions was discussed in class in connection with text material but the exact method of solution was left for

[4] Thurman M. Huebner, *Two Methods of Reporting Physics Laboratory Experiments*, Unpublished Master's Thesis, University of Chicago, 1937.

the most part to the ingenuity of the pupils. Perhaps the following example is illustrative:

1. How can you measure distances by the method of pacing? What is your average number of paces in a city block? How many feet are there in a city block? Measure the length of the room by the method of pacing and be prepared to report all results.

Some seventy problems of this type were finally prepared, subject to modification, covering the fundamental concepts and daily useful facts about measurement, mechanics, heat, sound, light and electricity. The pupils themselves introduce new problems from time to time and the list is rapidly growing. We feel that our democratic majority, that will never see college, has found in physics a new interest.

The time saving element of the test method and the stimulus of new material in our problem list are already being realized at Bowen High School. New equipment is being constantly devised, and definitely the junk pile has its use. We expect each pupil to keep his own notebook of data, subject to occasional criticism but largely in his own inimitable style, intelligible to himself and pertaining to his own work on the experiments assigned. At the end of each period of days covering the group of experiments assigned, a comprehensive examination is given and to the extent successful, experiments are credited. Make-up opportunity is given, once for each series, at a later date. Extra, voluntary experiments worked outside of class time are reported in formal style and credited immediately. Grading is a simple counting and normal curve process.

Our studies of the problems of laboratory effectiveness have undoubtedly been of greater value to us because of our participation than to the one who reads, but, knowing that the field is large and improvements can be made if properly sought, we pass on our results. Gains have been made in the following directions:

1. Greater pupil interest and less boresome bookkeeping.
2. Greater freedom for the teacher during laboratory time in dealing directly and intimately with pupils while at work.
3. Wider horizons in physics applications.
4. Scientific thinking of pupils directed along more effective lines by the use of proper questions.

The pupils have shown objective approval of the changes by casting a two to one vote in favor of the test method using problems selected from life situations. Is this surprising? Would we as adults enjoy baking a cake according to printed recipe and then writing a treatise on the purpose, method, sketch of equipment, data and results? Or would we simply eat the cake?

SOME EASY PROJECTS IN CHEMISTRY

Project 4, Fusible Alloys

By Charles H. Stone, *Brookline, Mass.*

AND

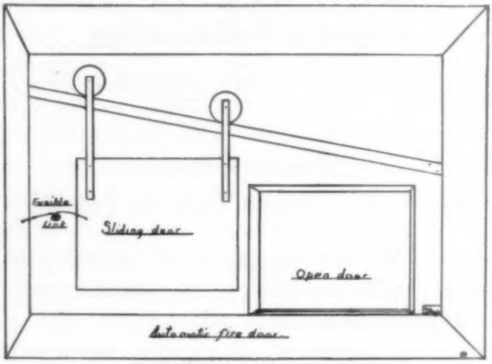
Rhenalda Herring,
Senior High School, Orlando, Florida

The fact that the melting point of an alloy is frequently below that of any of its components is used to produce alloys of very low melting temperature.

Among the more common alloys may be mentioned: type metal, Rose's metal, Lipowitz's metal, chromium steel and other steels, solders, and Wood's metal. Type metal is composed of lead, tin, and antimony. Since this alloy melts at such a low temperature and hardens quickly the cast can be made on moulded cardboard and can readily be used in a linotype machine. Rose's metal is made of bismuth, lead and tin; since it melts at 90 deg. C. it is used for boiler plugs and fuses. Lipowitz's metal will become soft at 55 deg. C and is used for making casts; it is an alloy of bismuth, cadmium, tin, and lead. Chromium steel and other steel alloys are used in automboile manufacture and for machine tools and for armor plate. Solders, used for light repairs such as mending cans, are made up of lead and tin in varying proportions. Wood's metal is widely used for automatic sprinkler systems and for the fusible link in fire doors.

I made Wood's metal by melting together in an iron crucible 50 g. bismuth, 25 g. lead, and 12½ g. each of cadmium and tin. When the materials were completely melted and well stirred I poured the hot material into a mold where it quickly solidified. The theoretical melting point of this metal is 60.5 deg. C., but my product melted at about 75 deg. C. From the 100 grams of material used, I obtained about 85 grams of the Wood's metal.

A small model of a fire door was made as shown in the accompanying drawing. The walls of the room and the sliding door itself were covered with sheet tin obtained from empty oil cans which were procured from a neighboring garage. Two checkers were used for rollers to operate on an inclined plane as shown in the drawing. The door was held back by a small link of my Wood's metal weighing about 1 g. When a lighted match was held under the link, the metal melted thus releasing the door



Model of a fire door.

which at once slid down the inclined plane so as to close the opening into the next part of the imaginary store or factory. This gives a pretty definite idea of how such a door actually works in a real store or shop. This was an interesting experiment. The materials cost only a few cents and the model can be made by anyone at all used to the handling of tools.

IRON CRYSTALS

We have just returned from an tuto trip through the Mother Lode country of central California, where we went to get geology and biology specimens for the School Research Association. Near Fresno we found a very interesting and peculiar formation. There was a great mass of slate, with layers tipped up almost vertical. Embedded in the sheets of slate were cubical crystals of iron. Some had rusted out or weathered out, leaving cubical holes. Others were entact, perfect cubes, about 2.3 cubic mm.

If any teacher, school, or museum desires specimens or photographs of this formation, I'll be glad to get just what is desired.

M. Arleigh, 418 W. Av. 37
Los Angeles, Calif.

SCIENCE IN THE CHICAGO PUBLIC SCHOOLS

By William H. Johnson
Superintendent of Schools, Chicago, Illinois

In Chicago we are giving constant attention each year to the problem of constructing our courses of study to fit the needs of boys and girls growing to maturity in a large industrial community. Where the *concentration of population is high*, the degree of *specialization* of human endeavor is *also high*. Accordingly each member of the *social group* must obviously regard with respectful intelligence the necessity for *fundamental cooperative effort*. This in turn requires a *well-informed type of citizen*. The person who can live *happily*, *successfully*, and *profitably* both for *himself* and his *fellow man* during the days of his youth and after reaching maturity, must meet obligations that become increasingly complex. In order to *meet these obligations*, in order to take his place as a *well-informed citizen*, in order to *make a living*, in order to *maintain health*, and *find happiness* in our modern streamlined civilization, a knowledge and understanding of many of the fundamentals of science is necessary.

In a community as large and complex as Chicago, the number of vocations is almost unlimited. Fortunately, these vocations fall into groups and the individual vocations within each group have much in common. Likewise, no matter what the interest or vocation of the individual may be the community as a whole has many problems which must be solved, and the solutions must be supported by an intelligent citizenship if the community is to survive and prosper. Both of these factors call for education and understanding in the fields of science.

The child's education in science begins in the Chicago public schools in the first grade. Needless to say he has no conception at this point of what vocation he will choose, or what the problems of the large city are. His relation to science as an individual is centered about a natural curiosity concerning many objects and living things with which he comes in contact. His community consists of the city block in which he lives, the neighborhood park or playground, and the "way to and from school." His horizon bounds a very limited area but within that area he discovers many things that are new. The habit of learning to identify these discoveries should be fostered. The curiosity of the young child concerning these things should be developed.

And what are some of the specific things that concern this young citizen as an individual and as a member of society—things that are related to science?

He is building a vocabulary through experiences. The vocabulary of the first grade child of today, living in a great industrial center, is far different from the vocabulary of the pre-primer written some years ago. He looks overhead and discovers an AEROPLANE, a product of scientific research, and the word and object are his. He may make his own AEROPLANE even though it consists of only a piece of paper tied to a string or folded to form a gliding dart. But to him his AEROPLANE is real and scientific. He becomes somewhat familiar with the AUTOMOBILE, the STOP and GO light, RED and GREEN—all necessary because of science. He may discover a sparrow building a NEST and learn that living things construct a HOME. MOTHER and FATHER help with the HOME and care for the BABY BIRDS. He may see the MOTHER and FATHER hunt for FOOD and get therefrom an example of family life. He will note the seasons and see things GROW and SLEEP. He will learn that all living things need FOOD and REST. He may see a train or street car and build his own. Although it may be only an orange crate—to him it is a powerful ENGINE. Or she may care for her DOLL and teach the "CHILD" to behave as well bred, well fed, children should. All of these things are the beginnings of science. True, they have no definitely stated problem, no well thought out plan of solution, no formal data are collected, evaluated, and interpreted in the manner of the research expert. They are the first impressions of childhood to be fostered as a fragile foundation or beginning, to grow into the more mature activities of later years. Snuff them out and you have a stunted, unbalanced individual who fails to find a fullness and satisfaction in living. Increase their number and you have a more fertile background for well developed citizenship.

He is laying the foundation for a vocation. The activity of the world at large is not confined to the covers of the textbook. The child likes to learn from his own experiences. Without a background of experience reading is an uninteresting, abstract, meaningless chore. The experiences of early years in the field of science provide the activity which gives meaning to words. He learns that: WOOD is STRONG, ICE is COLD, FIRE is HOT, SEEDS GROW, WIND BLOWS. He builds from wood.

He sees the water freeze and feels the cold ice melt. He learns that heat melts the ice to water. He cares for the seed and knows it will grow. He learns about the world around him by doing things with it. He loves to tell others about what he has done and to read to others about his own activity, a part of him because he has made it so. He has learned in an unorganized way some of the scientific background of his environment that relates to him as an individual, and some of the community problems related to him and to science, but he does not recognize these things as being related to science. To him they are part of an unorganized procedure which he does not systematize in his own mind. They are the panorama of his life as he lives it in his own limited way.

As the child grows and matures and moves from grade to grade, the size and complexity of his world increases. His curiosity concerning the identity and activity of objects, forces, and living things not only raises the question *"What is it?" but adds the additional inquiry "How does it work?"* He may wish to construct a magnet or even a tiny electric motor or a simple telegraph. His folded paper dart is now displaced by a model aeroplane with some kind of mechanical power. He talks of circuits, coils, cores, propeller pitch, struts, ailerons, and wing curvature. Temperature is no longer confined to the terms *hot* and *cold*. The thermometer is read in *degrees*. He will learn that with dirt and filth comes disease. He may expose a sterile culture to his dirty fingers, his cough or sneeze, or the dust from the schoolroom floor. He may develop an understanding of the reasons for community as well as personal sanitation. There will come a beginning of the conception of cause and effect, the ability to learn to control the operation of things through an understanding of simple relationships. The orderliness and vastness of nature may be discovered by observations made of the heavenly bodies. There will come a desire to collect, observe, investigate, construct, regulate, and understand. And why should these activities be permitted to occupy school time? Because through them the child is not only learning to *understand the world* in *which he lives* and *his relation to it*, but he is discovering his *likes and dislikes* for certain fields of activity, certain aptitudes that will help him *choose* a general field in which to work with interest and pleasure—to make a living—to be a profitable citizen both to himself and to the community of which he is a part. And by many this choice can be made

with greater intelligence *if they have had experiences in the field of science.*

As the student matures and expands his horizon he *continues* to discover more things and to learn their identity. He *continues* to investigate *more carefully* and *more thoroughly* how they work and what they will do under given conditions. These *habits of living* in a world of "scientific things" should *never cease to function.* With adolescence developing, *a new question arises* concerning these "scientific things," "*What are they good for?*"—or, stating it another way, "*Are they good for anything of interest to me?*" *Science now begins to have a vocational value.*

The student may not know at the beginning of his high school career exactly what vocation he will follow when his school days are over, but he will know, very likely, in what general field his interest lies. By the time he has completed his opportunity for exploring the problems offered in his high school courses in General Science, *he should have sufficient background for an intelligent citizenship related to this general vocational field.* He will have an elementary understanding of the structure and function of the principal parts of his own body. He should know the value of a good community water supply and sewage disposal system; the necessity for cooperative effort to control community health. He should understand something about the reasons for eating a well balanced diet of wholesome food, getting plenty of rest, fresh air and sunshine, and the harmful effects of over-indulgence in any form.

The physical world will have presented a challenge to his imagination and in it he will have found new fields to conquer. Energy, in its farious forms, has been available to his manipulation and he has placed it under his control. He understands that science has contributed to his own welfare as an individual and to the welfare of the community at large. He sees the *utility value of learning in this field.* He now thinks with three questions in mind concerning the scientific value of things:

1. What are they?
2. How do they work?
3. How can they be made useful?

It is doubtful that unskilled man can ever again compete with machine labor without government subsidy. Skilled labor will always be in demand. Unskilled labor will find it increasingly difficult to maintain economic independence. Thus, it is

importance that the student be given every opportunity and all of the *guidance* possible to enable him to discover the vocation of his choice. It is also important that when that choice has been made, the public school extend every effort to help him secure the training and education that will make him successful in his chosen field. It is the business of the school to *help the student choose well* and once that choice has been made to *make instruction interesting and worthwhile*. At the same time the instruction must be sufficiently significant to be of value in the years to come.

The kind of science instruction he receives *after* he has made his choice of a vocation will probably *differ with each field of endeavor*. There has been a great deal of *talk about the education and training of the individual pupil* but there has been *too little done* to break down courses of subject matter to fit individual needs or the needs of individuals within a related group. The literature of Chaucer and Spencer, or the gas laws of Charles and Boyle may have little value for our high school student when next year he finds himself sitting in an employment office waiting his turn. In addition to culture he must have an education which will help him to make a living. Science, as well as other fields of learning, can do this if it is related functionally to the chosen vocation.

Let us suppose that our prospective graduate has shown a desire to work in the metal trades and states that his ambition is to become a first class machinist. He will, of course, be given every opportunity to work under guidance in the school machine shop and other shops related to this field, such as forge and foundry. It will also be necessary for him to have some work in related drawing and mathematics. His English may not be a study of the classics but could properly consist of "Trade Information" related to the problems of his work. His interest in the subject matter of his shop course should encourage him to develop the habit of reading. He should see value in this reading material because it is related to what he knows to be useful. Likewise, his written composition about how to shape a piece of steel in a lathe is of greater value than one entitled "How I will Spend the Fourth of July." Trade journals and technical works from the school library become the sources of information for his English composition. From this type of literature he will learn a great deal about his trade, its history, its place in industry and recent developments in the field.

His science cannot merely be the traditional chemistry and physics courses. He will be interested and must have instruc-in problems pertaining to machine design. Both in the science laboratory and the science classroom his work in mechanics will develop an understanding of the different fundamental forms of simple machines, of force, work, power, and efficiency. Because, more and more, shops are using electricity as a source of power he will need some laboratory instruction in the electrical field. He will deal primarily with metals. Therefore he must be made familiar with the various kinds of iron and steel, and non-ferrous metals, and their alloys, so that he may recognize them and know their properties and characteristics, where and when they are of value and when they are not suited for a given job. There will not be time or place for much of the theoretical or so-called "pure science" in this related science course, but there is nothing to prevent him from studying in that field later in life if he chooses to do so. The important thing is that his instruction in English, mathematics, drawing, science, and shop work leads to a specific objective. He is prepared to take his place in industry when he graduates from high school. His practical experience in school will make it easier for him to become a skilled workman on the job. The demand for the service he is prepared to render will enable him to become a self-sustaining and useful member of society. His education will not consist chiefly of information for which there is no market value when he applies for a job.

Now in contrast the boy who is preparing to become a machinist with one who expects to enter the electrical field. The symbols used in machine drawing differ from those used in electrical work. Obviously his drawing course will differ. Likewise his English, mathematics, and shop work will relate to the problems of the electrical industry. In science his laboratory work will include much less in the field of mechanics but will stress problems pertaining to magnetism and electricity. If his interest is in radio or its allied lines it will include some experimental work in sound. He will study electric circuits of many kinds,—transformers, generators, motors,—and become familiar with various types of electrical testing instruments. His vocabulary, problem solving ability, understanding of scientific principles, and skill with the tools and instruments of his craft will differ from that of the machinist.

Obviously, it will not be possible to prepare every student for

a specific trade or vocation. We are seeking advice from industrial and civic leaders who are successful in the business world concerning their needs. We are noting trends in industry and business in order to determine which lines of endeavor can be helped specifically by training and education in the school. Not all of these lines of work require training in science beyond the General Science offered in the ninth grade of our high schools.

There is one vocation for which every girl should be prepared —that of becoming a wife and mother. To that end every Chicago high school will soon be equipped with a Home Arts Laboratory. This will consist primarily of a three room suite: living room, kitchen and dinette, and bath. Here every girl will receive instruction in home-making and child care, under conditions reasonably similar to those she will find in a modest, modern home.

Every girl who studies in the Home Arts Laboratory should receive instruction in related science, particularly in the field of biology. Anticipating marriage and possibly motherhood she should have an intelligent understanding of the manner in which living things carry on their life processes. She must learn about food and its relation to growth and good health; the common causes of illness, and the prevention of disease; the influence of heredity on future generations; the functions of the organs of the human body and, if possible, their care. She must learn much about herself by comparing her own growth and development with simple forms of life because through such comparisons she gains a better understanding of how her own body functions. The more she knows about living things the better she will be able to manage the household and plan for those who are entrusted to her care.

While this program of vocational education and training is being developed, one must not lose sight of the fact that some of our students will continue to go to college. Because they will attend school for a longer period before beginning to specialize in professional work they can afford to build their education on a broader base. It is to be expected that, with the professions becoming more and more complicated and more highly specialized, only those who have the keenest minds can hope to be highly successful in professional work. Practically all schools which are training students to enter the professions state that we need fewer but better doctors, lawyers, and engineers. If that is true, it is almost useless for one who has not exceptional

ability to attempt professional work. Both the time of the student and the effort of the school in his behalf will be wasted. An intelligent guidance program should make students aware of this situation before the waste occurs.

For those who do prepare for the professions, the science course should be rich with the theoretical as well as the practical developments in science. Such persons must learn to understand how theory is developed and applied. They must learn to recognize a problem and break it down by systematic analysis, gather evidence from intelligently controlled observation, evaluate that evidence, and draw conclusions which will lead to the correct solution to the problem. They must have unlimited patience and persistence as well. Their paths will be strewn with many failures and disappointments. They must be willing to sacrifice personal financial gain from their work for many years following the training period. The type of science education that they receive will be much more difficult to master than that provided for the vocational students who must earn their living immediately after they leave the high school.

The value of any program of education will depend largely upon the ability of the teacher in the classroom, laboratory, or shop. There is and has been for a long time a great deal of inertia in the classrooms of our American schools. Teachers as a group tend to lead too cloistered an existence; to confine themselves too rigidly to association with their own kind, and so know too little about how the rest of the world conducts its affairs. Because so many teachers lack this contact with things outside the schoolroom the products of our educational system are often said to resemble hot-house plants, not well prepared for transplanting from school into the world of work.

It seems reasonable to suppose that teachers can benefit from a personal study of the vocations and some experience in the world of work outside the classroom. Many, of course, would look upon such a requirement as an uncalled for hardship. They should find some comfort in reflecting that there are many others in the same class and they are not all school teachers. Flexibility and readiness to adapt one's self to new developments and changing conditions are requirements of all professions. No longer can teachers hope to have the support of public funds if the result of their work remains all too intangible. Our high schools, especially, must produce something that is real and substantial.

HOW FIFTY-ONE WELL-KNOWN EDUCATORS ANSWERED A QUESTIONNAIRE CONCERNING THE TEACHING OF SCIENCE IN THE ELEMENTARY GRADES

By David W. Russell
National College of Education, Evanston, Illinois

Here are the responses of the fifty-one well-known educators[1] to the questionnaire that was sent to a selected group of curriculum and science education experts last spring and published in School Science and Mathematics in the October issue.[2] The specialists answered the questionnaire by checking their opinions on the questionnaire form and by making qualifying comments which have been summarized after each part of the numerical data. To interpret the data use Item 7, Part A as an example. "The teaching of science in the elementary grades is justified because it offers a good approach to other elementary subjects and activities." Using the data that are expressed in percentages in the columns we find that 2 per cent of the specialists were strongly opposed (SO) to this statement, 6 per cent were opposed (O), 26 per cent were indifferent or noncommittal (I), 56 per cent were favorable (F) and 10 per cent

[1] Appreciation is expressed to David P. Harry, Graduate School, Western Reserve University, for helping to prepare the questionnaire and for guidance in carrying on the study, and to the following specialists in curriculum and science education who answered the questionnaire and made comments on the questionnaire topics: Wilfred M. Aikin, Ohio State University; Edna Dean Baker and Clara Belle Baker, National College of Education; Wilbur L. Beauchamp, University of Chicago; Florence Billig, Wayne University; Glen O. Blough, Colorado State Teachers College; J. Franklin Bobbitt, University of Chicago; Herbert B. Bruner, Columbia University; Hollis Caswell, Columbia University; Gerald S. Craig, Columbia University; W. C. Croxton, State Teachers College, St. Cloud, Minnesota; Harry A. Cunningham, Kent State University; Francis D. Curtis, University of Michigan; Ira Davis, University of Wisconsin; Elliott R. Downing, University of Chicago; Mildred Fahy, Peirce School, Chicago; O. D. Frank, University of Chicago; Earl R. Glen, State Teachers College, Montclair; Theodosia Hadley, Kalamazoo Public Schools; Jennie Hall, Minneapolis Public Schools; Henry Harap, George Peabody College; Lillian Heathershaw, Drake University; Nelson B. Henry, University of Chicago; George W. Haupt, State Teachers College, Glassboro; George W. Hunter, Claremont College; Susan Isaacs, University of London, England; Ralph B. Jones, Peabody School, Fort Smith, Arkansas; William H. Kilpatrick, Columbia University; Alfred Kinsey, Indiana University; C. C. Mason, University of Tulsa; W. A. Matheny, Ohio University; Morris Meister, New York Public Schools; Victor Noll, State Teachers College, Kingston, R. I.; E. Laurence Palmer, Cornell University; Bertha Parker, University of Chicago; Edith Patch, University of Maine; Ellis C. Persing, Western Reserve University; S. Ralph Powers, Columbia University; Marjorie Pratt, Shorewood Public Schools; Bertha Stevens, Avery Coonley School; W. S. Teeters, St. Louis Public Schools; Gilbert Trafton, State Teachers College, Mankato, Minnesota; O. F. Underhill, State Teachers College, New Britain, Connecticut; Douglas Van Bramer, Chicago Public Schools; William C. Vinal, Massachusetts State College; Ralph K. Watkins, University of Missouri; Hanor A. Webb, George Peabody College; Harrington Wells, Santa Barbara College; G. W. Whitman, Massachusetts State College, Salem; and Margaret Wilt, Chicago Public Schools.

[2] Russell, David W., What are Your Opinions about Teaching Science in the Elementary Grades? *School Science and Mathematics*. XXXVIII (October, 1938) No. 7.

were very favorable (VF) to justifying elementary science for this reason. Now compare your own opinions on the questionnaire that was published last month with the responses of the curriculum and science education specialists and there will be some surprises in store!

TABLE I

PART A. WHY TEACH ELEMENTARY SCIENCE?

	SO	O	I	F	VF
The teaching of science in the grades is justified because it . . .					
1. helps children to appreciate their environment and to understand important relationships of living things.	0	0	0	26	74
2. tends to raise the achievement in science in the upper grades due to preparation in the lower grades.	4	2	34	42	18
3. offers good opportunities to develop favorable character and personality traits in children.	2	4	20	40	34
4. aids children to form habits and attitudes of scientific thinking and scientific doing.	0	0	4	28	68
5. provides information which children can use in their everyday living.	0	0	6	44	50
6. uses subject matter that is naturally interesting and stimulating to children in elementary grades.	0	0	10	56	34
7. offers good approach to other elementary subjects and activities.	2	6	26	56	10
8. provides a good avenue of approach to incidental sex education at an early age.	0	0	18	64	18

Comments.—The "values" of subjects or activities has always been a topic for lively discussion ranging from arguments on the transition of training to the mental disciplinary qualities of subject matter. Some of the comments recommended further research such as suggestions that surveys be made to determine the needs of children which can be met by teaching elementary science before we "justify" it. Others asserted that mere pleasure and satisfaction derived from knowledge and appreciation of things were themselves the ends of education. The distinction between elementary science and nature study was pointed out along with the comment that elementary science should supply well-rounded experiences for children providing they constituted the primary motive for including the subject in the curriculum. A few respondents questioned "values" and "justifications" and declared that if it could be proved that elementary science fulfilled any *one* of the items on the questionnaire the

subject would be justified without further defense. Many of the remarks implied that the importance of elementary science lay in any help it can give in providing children with an informational basis for intelligent living, and, as one person humorously added, "for using ordinary 'horse sense' in carrying on the things they do!" There was little doubt that the group, as a whole, approved of including science in the elementary school curriculum.

TABLE II

PART B. SELECTING THE FIELDS OF SCIENCE

	SO	O	I	F	VF
Subject matter in the elementary school science curriculum should . . .					
1. combine the elements of nature study and natural science throughout the elementary grades.	2	20	32	30	16
2. combine important phases of natural science and physical science throughout the grades.	2	2	20	32	44
3. strongly emphasize nature study in the primary grades and lead to a growing emphasis upon physical science in the elementary grades.	14	30	26	20	10
4. depend upon no general plan for including certain fields of science, but should include material that is best adapted to interests and attitudes.	8	28	12	22	30

Comments.—There are at least twenty-two major divisions of science that contribute to the average elementary science program according to a recent report. If this is true, the choice of material becomes a matter of selection rather than search. There were several persons who emphasized that science material should be taken from any field that is adapted to the interests and attitudes of the class for, after all, the division of subject matter fields is really insignificant. One strong plea was for a "core curriculum" with science as the core but not based on the interpretation that was stated recently at a curriculum conference that "the core is the part of the fruit that is discarded!" A majority of the comments generally implied that selection of science fields really depended upon classroom situations and two persons boldly asserted that the interests of the teachers should be considered as well as the interests of the children. It was hinted that "teacher interest" was a strong factor in bringing a classroom to life and making it live! Several persons commented on the fact that fields of science can not be chosen as sources of content, but the science curriculum should be moulded around units of experiences concerned with social and industrial

developments, especially those related to the life of the child. In general, it seemed apparent that material should be taken from as many fields of science as the traffic will bear and a basic plan for selection was unnecessary.

TABLE III

PART C. HOW SHOULD SUBJECT MATTER BE SELECTED?

The selection of content for the science program should be based on . . .	SO	O	I	F	VF
1. an analysis of subject matter prescribed in several good courses of study.	12	24	22	40	2
2. "children's interests" which have been reasonably determined by good research studies or from other sources.	2	8	22	58	10
3. topics related to children's observations, discoveries, and questions as nearly as possible at the time when they occur.	0	4	8	60	28
4. science phenomena in the immediate environment of the school or the home.	0	2	4	56	38
5. children's ability to understand science phenomena according to studies that have been made.	2	0	20	52	26
6. the principle that science in the elementary grades should be taught as a foundation for the work that is to come in the upper grades.	14	42	20	20	4
7. children's current needs for understanding, enjoyment, and safety in living their own lives.	0	0	8	34	58
8. common experiences of children at home and at school including other subjects as well as science.	0	4	16	48	32
9. an analysis of well-known elementary science textbooks or readers.	24	16	22	34	4
10. seasonal or other natural changes in environment.	2	6	20	56	16
11. the needs of the community for an understanding of the principles of elementary science related to everyday activities.	0	2	24	50	24

Comments.—"The curriculum," like "current and social problems," are nowadays familiar words to the butcher, baker, and candlestick maker, and are usually passwords for good discussions. There were extensive comments on "content" and many of them were definite in asserting that environment is the thing! But environment in some cases was interpreted to mean the atmosphere, the earth, celestial bodies, and almost anything within the visual and imaginable range of the child in contrast to other interpretations meaning simply home and school surroundings. Several statements mentioned that the classroom

teacher was usually an excellent judge of the material to be taught and considerable reliance should be put on teachers' selection of activities. Other suggestions ranged from using material related to the chief industries of the community and immediate needs of the child and the home, to arranging material in some fashion for the classroom teachers to follow. A few comments dwelled on child interests and mentioned that they should be utilized as much as possible but were secondary to other more important criteria for selecting curriculum content.

TABLE IV

PART D. WHO SHOULD TEACH ELEMENTARY SCIENCE?

The elementary school science classes should be taught by . . .	SO	O	I	F	VF
1. a specially trained elementary school science teacher who may have other incidental responsibilities in the school.	4	6	20	30	40
2. a special teacher who conducts the science classes in addition to some other classroom teaching responsibilities.	4	18	26	46	6
3. the regular classroom teacher who teaches science in her grade as well as several other subjects.	0	12	12	40	36
4. a science supervisor or visiting teacher who gives demonstration lessons; the classroom teacher directing the work between visits.	8	32	16	26	18
5. one of a group of regular classroom teachers who assumes the responsibility of the science program according to agreement with the other teachers.	4	16	30	44	6

Comments.—Within the last decade many elementary school teachers have risen from the "school mam" category to become educational and community leaders, and in many ways have carried the burden and taken the raps and criticism for many of the new-fangled ideas in their continual struggle for better and more sensible schools. Many of the respondents wanted the classroom teacher to handle the science program but deplored the fact that many teachers were unprepared through little fault of their own. The suggested remedy was to have better science instruction in teacher training institutions and universities and to make science as functional and vital to the prospective teachers in their training courses as they are expected to make it functional and vital in the lives of the children they are to teach. Others mentioned that the subject matter needed by teachers

is not highly specialized material but rather a "plough depth" introduction to the many fields. One respondent firmly objected to the many "should do's" that are constantly thrown at elementary teachers with more emphasis on their "want to do's" and more latitude in planning their own class room programs.

TABLE V

PART E. HOW SHOULD ELEMENTARY SCIENCE BE TAUGHT?

	SO	O	I	F	VF
Learning experiences in elementary school science should be provided by . . .					
1. the incidental method, or developing interests in science phenomena at the time when these interests seem evident.	14	18	20	32	16
2. using a definitely planned unit to be completed within a specific number of class periods, days, or weeks, but including provisions for individual differences.	6	36	20	22	16
3. a prepared activity unit with an elementary subject as a core but with adequate opportunity for related science activities that may develop through children's suggestions and attitudes.	4	12	22	28	34
4. a unit built around a science concept as a core and incorporating other fields of interest as the the unit develops.	4	6	18	36	36

Comments.—The subject of method has always been a sensitive spot in educational theory since it includes, in some way, just about all the other topics on the questionnaire. It was emphatically stated several times that elementary science should not be concerned with mere fact-getting but should be developed with primary emphasis on teaching important scientific principles, developing the scientific attitude, and using scientific methods. This is, of course, quite a large order for the elementary grades. A few remarks were related to the idea that children must learn by doing but the idea was challenged when "doing" was interpreted to mean only bodily activity. "No," wrote one person, " 'doing' includes mental as well as physical activities!" A few remarks recommended definitely planned and organized units, elastic in their application but well defined to avoid haphazard educational experiences for children. The incidental method was not looked upon with as much favor as the data seems to indicate in view of the comments. One person said, "The incidental method is all right if it is 'well planned' by the classroom teacher."

TABLE VI

PART F. SHOULD ELEMENTARY SCIENCE BE RELATED TO OTHER SUBJECTS?

	SO	O	I	F	VF
An acceptable program in elementary science should be especially associated with . . .					
1. the program of silent reading instruction.	10	4	14	58	14
2. the course of study in geography.	8	6	30	44	12
3. the course of study in arithmetic.	10	14	32	42	2
4. the course of study in the social sciences.	2	6	28	54	10
5. the health program, including physical education, nutrition, and personal hygiene.	2	4	8	52	34
6. as many subject fields as are necessary to carry on the purposeful science activities.	0	2	10	34	54
7. activities that are basically in the field of science; learning experiences in other subjects should take place in the time allotted to them.	6	20	16	32	26

Comments.—Two of the first cousins in educational theory are integration and correlation. A few comments implied that the two cousins have grown up and are not as important as they used to be. Some of the respondents believed that the relationship of elementary subjects depended primarily upon administrative tactics and that the topics could be best handled by first considering individual classroom situations. There were a few strong implications that in rational reckoning "science is science" and that there are enough relationships within the subject itself without purposefully planting it in other fields of instruction. Many comments mentioned the point that while integration and correlation were factors of good educational theory they were only practical when the relationships involved were natural and not forced. It was mentioned that the tendency was often to give the curriculum the "third degree" by forcing relationships for the sake of a well dressed course of study whether they were natural or otherwise. A further comment stated that planning relationships could easily be another "crutch" for less gifted children. The "normal" and gifted child is able to meet his needs for correlation and integration under his own power if properly guided. A cross-section of the majority of comments showed that the grain pointed towards the idea that activities should not be designated according to subject matter division but rather included in units of experiences with a basic amount of science involved and as many other fields of activity included as well. As one commentator said: "Don't overdo it, keep the relationships natural!"

TABLE VII

PART G. HOW SHOULD TEXT-BOOKS BE USED?

For an acceptable program of elementary science there should be . . .	SO	O	I	F	VF
1. a standard or adopted text-book with the subject matter and the activities taken from the book.	38	28	14	18	2
2. a standard or adopted text-book to be used with other reference material such as magazines, pictures, library books, etc.	10	22	20	26	22
3. considerable reference material including field trips, magazines, etc., but using a text-book as the core of the curriculum or unit.	0	14	8	40	38
4. teacher-motivated discussions, explanations, demonstrations, and related activities with references made to books only when actually needed.	0	10	8	44	38
5. several standard or adopted text-books, perhaps one related to physical science, one to biological science, or some similar plan.	16	32	32	16	4

Comments.—Throwing overdoses of "research technique" at children in the elementary school under the guise of the "scientific method" and "do your own critical thinking" was strongly assailed by several persons. A few others mentioned that text-books are exceedingly important but suggested that the stigma

TABLE VIII

PART H. HOW MUCH TIME SHOULD BE ALLOWED FOR ELEMENTARY SCIENCE?

For an acceptable science program in the elementary grades . . .	SO	O	I	F	VF
1. at least a daily half-hour period at a scheduled time should be used for teaching science.	8	14	36	24	18
2. at least one hour each day at an appropriate time should be used for teaching science.	24	24	28	16	8
3. sufficient time should be allowed each day to develop the science or related activities according to the judgment of the teacher.	4	14	12	32	38
4. time spent in the classroom is immaterial as long as the children's responses are spontaneous and stimulating to creative activity.	14	20	20	30	16
5. children should be asked to spend considerable time out of school to carry on science activities in order to make the program continuous.	10	26	36	20	8
6. the time allotted should be as much as the time allowed for any other subject in the elementary school curriculum.	6	6	42	16	30

of "text-book" be left out of children's reading matter. Books are important in teaching elementary science and demonstrations are equally important to draw alert children into interesting and happy activities. The few other comments ruled out text-books and emphasized the use of many references whether they were books, magazines, periodicals, or whatever, as long as they presented suitable material.

Comments.—The "haven't time" pleas of teachers were noted by the educators who mentioned that unless time was definitely allotted for science it would have little opportunity to become a vital part of the curriculum and would gradually settle to the bottom. Some statements specified that it was better to have less time given more often than a longer period given occasionally, but the summary of comments followed the middle path and suggested that time allotment could be determined only by administrative and curricular situations in each school and that specific time allotment was not so important just so long as time for elementary science was available and was used.

TABLE IX

PART J. WHAT SPACE AND EQUIPMENT SHOULD BE USED?

For an acceptable science program in the grades it is a good policy to use . . .	SO	O	I	F	VF
1. a special classroom equipped for science activities.	0	6	20	36	38
2. a well-equipped science laboratory arranged for demonstrations, lectures and individual experiments.	4	10	46	34	6
3. inexpensive and free science material in the classroom and in the laboratory.	0	2	6	42	50
4. space in the regular classroom for science experiments and related activities.	0	6	6	36	52
5. the outdoors as much as possible as the science laboratory.	0	0	2	22	76
6. material such as exhibits, films, and pictures furnished by museums, visual education bureaus and other organizations.	0	0	4	36	60
7. no special equipment but to depend upon reading, discussion, and explanations for instruction.	58	32	10	0	0

Comments.—Some administrators have been pleased to know that a few of the individual comments strongly implied that much can be accomplished in teaching elementary science without elaborate equipment and space in the school buildings. One person dwelt extensively upon the value of the teacher's per-

sonality and interest as superior in importance to space and equipment. There were several persons who held fast to the special laboratory idea or at least a classroom fully equipped with laboratory material. The value of "laboratory techniques" was discounted by a few respondents and one remarked that "... you can't teach scientific attitudes simply by using standardized equipment housed within four walls. While equipment helps, it is only one chapter of the story!"

TABLE X

PART K. IS THE RADIO IMPORTANT IN THE ELEMENTARY SCIENCE PROGRAM?

	SO	O	I	F	VF
Radio broadcasts can be made an integral part of the science program in the elementary grades by ...					
1. including them as a part of the regular elementary science course for all grades.	6	24	28	28	14
2. having the use of the broadcasts optional with each classroom teacher.	0	22	32	32	14
3. making the radio broadcasts the core of the science program in all classes.	34	44	22	0	0
4. using radio broadcasts to supplement and intensify the regular science program in all classes.	2	2	18	40	38
5. providing supplementary material explaining the nature of the broadcasts several days before the radio programs.	0	8	16	50	26
6. utilizing radio broadcasts as enirichment material for those pupils who voluntarily listen at home or at school.	0	6	16	50	28
7. making radio programs a part of the required home assignment.	18	44	24	12	2

Comments.—The radio is one of our fastest growing educational babes, but the topic brought only a few comments probably because education by radio is in its infancy. In general, the comments agreed that radio education had many possibilities, but explained that the chief reason for opposition to radio broadcasts for science education was that the programs were not yet organized to meet the needs of the curriculum, except in certain cities. Some respondents prophesied that in radio are some of the best opportunities to enrich the elementary school experiences and hoped that immediate research would be carried on for determining the use of radio, planning broadcasts, and evaluating the programs.[3] In general, radio broadcasts were

[3] Among the organizations investigating radio broadcasts and education are "Evaluation of School Broadcasts, A Study Sponsored by the Federal Radio Commission Committee of the Federal Communication Committee" and the "National Committee on Education by Radio" in New York City.

recognized as valuable supplementary material. Teachers worried about being replaced by radios can have comfort in the statement of one strong advocate for radio education, who said: "Don't worry! Radio will never replace teachers in good school systems, radio programs will increase the need for good teachers!"

TABLE XI

PART L. HOW SHOULD WE MEASURE CHILDREN'S ACHIEVEMENT IN ELEMENTARY SCIENCE?

	SO	O	I	F	VF
Children's achievements in the elementary science program should be evaluated by . . .					
1. objective measurement of their knowledge by using standardized tests.	12	14	30	36	8
2. objective measurement of their knowledge by using teacher-made tests based on the material that has to be taught.	0	10	22	38	30
3. a rating plan, check-list, scale, or record blank for the teacher's evaluation of children's appreciation and interest in elementary science.	0	8	28	52	12
4. a rating plan, check-list, scale, or record blank for the teacher's evaluation of children's performance in science activities.	0	4	22	62	12
5. objective and subjective measurement of children's ability to use scientific facts and principles in their reasoning.	0	2	16	34	48
6. use no rating scale or measurement other than the teacher's judgment of the children's behavior and attitude in significant situations of living.	10	40	34	12	4
7. objective and subjective measurement of children's understanding and adjustment to their environment.	0	6	18	46	30

Comments.—Measurement of factual knowledge has, of course, just about reached the fifteenth round in the educational ring with no decision as far as elementary education is concerned. It was suggested that it would be wise to measure the use made of scientific facts and principles in applicable situations in children's lives, but just how to apply the yardstick is the question. One person was convinced that there was no satisfactory way to do this and believed that objective measurement of achievement in elementary science might just as well be forgotten for awhile. Some others suggested that the only test of achievement was by observation of the children's reactions, but they were afraid that the children at the ends of the behavior scale would receive most of the benefit of the measurement technique since the

normal child is sometimes the "forgotten child" in this world of complexes and problems, pseudo or otherwise. A few persons remarked that the elementary school teachers should be allowed to evaluate in their own way. The data and comments indicated, however, that there was a need for some sort of measurement procedure.

TABLE XII

PART M. WHO SHOULD SUPERVISE THE ELEMENTARY SCIENCE PROGRAM?

	SO	O	I	F	VF
The elementary science program in a city school system should be supervised by . . .					
1. a special supervisor in science with advisory capacity for grades one to twelve.	6	16	32	26	20
2. a special supervisor in science with advisory capacity for grades one to six.	6	2	16	50	26
3. a specialist whose work is to demonstrate science teaching in the grades.	6	14	26	28	26
4. the elementary school supervising principal.	6	20	44	16	14
5. the head of the elementary science department or general science department.	6	14	48	28	4
6. the classroom teacher using her own means of supervising	10	34	36	14	6

Comments.—The "snoopin' supervisors" of the last decade have snooped long enough according to several commentators. A person known as a curriculum coordinator was suggested to conduct a sort of clearing-house for planning the curriculum and to give the teachers a chance to be creative and original as well as the children. Other remarks clearly indicated that supervision was very important and more so now than ever in view of the many specialties that have entered education. One writer stressed again the importance of the personalities of the supervisors or coordinators who should serve as advisors to teachers of science, help to oversee the whole curriculum, and to stir up a few new ideas where stirring is needed.

To further compare your opinions with those of the fifty-one specialists check your responses on the summary arranged in Table XIV. In the first column of the summary are all the items that were approved by 70 per cent or more of the specialists with the percentage of approval indicated after each item number. In the second column are listed the items that were disapproved by 30 per cent or more of the respondents and in the last column are the items that were neither approved nor disap-

Table XIII

Part N. What Name Should Be Given to the Elementary Science Curriculum?

The most appropriate name for the science program in the elementary grades is . . .

1. Elementary Science	26	5. Natural Science (in the Grades)	6
2. Grade Science	0	6. Nature Study (in the Grades)	8
3. Science in the Elementary Grades	4	7. Nature Study and Elementary Science	6
4. Science in the Elementary School	48	8. Elementary Science Course of Study	2

proved according to the criteria used. To use Table XIV check your items of agreement with the specialists on the lines following the item numbers and use the topics of disagreement for further discussion and analysis.

Table XIV

Summary of the Questionnaire Items Checked by the Fifty-One Educators Arranged According to Percentages

	70% Or More Favorable (35 Items)	*30% Or More Opposed (20 Items)*	*Middle Path Indifferent (22 Items)*
Part A Justification	A- 1(100)[4] ____	None	A-2(6–60)[6] ____
	A- 4(90) ____		A-7(8–66) ____
	A- 5(94) ____		
	A- 6(90) ____		
	A- 8(82) ____		
	A- 3(74) ____		
Part B Science Fields	B- 2(76) ____	B-3(44)[5] ____	B-1(22–46) ____
	B- 4(46) ____		
Part C Content	C- 4(94) ____	C-6(56) ____	C-2(10–68) ____
	C- 7(92) ____	C-9(40) ____	
	C- 3(88) ____	C-1(36) ____	
	C- 8(86) ____		
	C- 5(78) ____		
	C-11(74) ____		
	C-10(72) ____		
Part D Science Teacher	D- 3(76) ____	D-4(40) ____	D-2(22–52) ____
	D- 1(70) ____		D-5(20–50) ____
Part E Method	E- 4(72) ____	E-2(42) ____	E-3(16–62) ____
		E-1(32) ____	

[4] Interpretation of A-1, One hundred per cent of the respondents checked their approval of this item on the questionnaire.

[5] Interpretation of B-3, Forty-four percent of the respondents checked their disapproval of this item on the questionnaire.

[6] Interpretation of A-2, Six per cent of the respondents checked their disapproval of this item and sixty per cent checked their approval of this item on the questionnaire.

Part F Integration	F- 6(88) ____ F- 5(76) ____ F- 1(72) ____	None	F-2(14–56) ____ F-3(24–44) ____ F-4(8–64) ____ F-7(26–58) ____
Part G Text-books	G- 4(82) ____ G- 3(78) ____	G-1(66) ____ G-5(48) ____ G-2(32) ____	None
Part H Time Allotment	H- 3(70) ____	H-2(48) ____ H-5(36) ____ H-4(34) ____	H-1(22–42) ____ H-6(12–46) ____
Part J Equipment	J- 5(98) ____ J- 6(96) ____ J- 3(92) ____ J- 4(88) ____ J- 1(74) ____	J-7(90) ____	J-2(14–40) ____
Part K Radio Programs	K- 4(78) ____ K- 6(78) ____ K- 5(76) ____	K-3(78) ____ K-7(62) ____ K-1(30) ____	K-2(22–46) ____
Part L Measurement	L- 5(82) ____ L- 7(76) ____ L- 4(74) ____	L-6(50) ____	L-1(26–44) ____ L-2(10–68) ____ L-3(8–64) ____
Part M Supervision	M- 2(76) ____	M-6(44) ____	M-1(22–46) ____ M-3(20–54) ____ M-4(26–30) ____ M-5(20–32) ____

So far the data related to the teaching of science in the elementary grades have been presented on a more or less theoretical approach based on expert opinions of how science should be handled in the elementary grades. At the Annual Convention of the Central Association of Science and Mathematics Teachers in Chicago, November 25 and 26, these questions will be further discussed by a panel[7] including several of the specialists who answered the questionnaire. There will also be a demonstration of a radio lesson in elementary science to compare with the opinions on the radio section of the questionnaire.[8] A further study[9] has been made of the actual practices in fifty selected

[7] Members of the panel who will discuss problems in the teaching of elementary science at the Annual Meeting of the Central Association are Paul G. Edwards, Chairman, Chicago Public Schools; Clara Belle Baker, Director of the Children's School, National College of Education; Dr. W. C. Croxton, State Teachers College, St. Cloud, Minnesota; Mildred Fahy, Principal of the Peirce School, Chicago; Lillian Heathershaw, Drake University; Ralph B. Jones, Principal of the Peabody School, Fort Smith, Arkansas; Dr. Louis M. Heil, University of Chicago; Ellis C. Persing, Western Reserve University; Dr. E. T. McSwain and Dr. Walter A. Anderson of Northwestern University.

[8] The radio demonstration will be conducted by Mary Melrose, Supervisor of Science of the Cleveland Public Schools with a fourth grade class furnished by Veva McAtee, George Rogers Clark School, Hammond, Indiana.

[9] For a complete analysis of this survey see "An Analysis of Opinions and Practices Concerning the Teaching of Science in the Elementary Grades," by David W. Russell, Graduate School Library, Western Reserve University, Cleveland, 1938.

schools in teaching elementary science and in a forthcoming issue of SCHOOL SCIENCE AND MATHEMATICS these data will be compared with the opinions of the specialists that have been given on the questionnaire.

USES OF CERTAIN TOPICS IN ALGEBRA

By LEE EMERSON BOYER
State Teachers College, Millersville, Pennsylvania

Every mathematics teacher must have felt at one time or another the need for an ability to enumerate specific uses for certain topics in algebra. Although it is commonly understood that mathematics in general, and algebra in particular, is used extensively by engineers and other technical experts this thought is not wholly satisfying to the expert algebra student or teacher who delves into details. He would like to know specific cases in which algebra concepts or techniques are used. Knowing that few mathematics teachers have had opportunity to study in the many fields where algebra is used the writer, in collaboration with other mathematicians,[1] presents specific uses for seven topics in algebra whose applications are not commonly known in the hope that it will enable students and teachers to satisfy, to some degree, the eternal query "Why Study Algebra?"

The seven topics with uses for each follow:

IMAGINARY NUMBERS

1. In connection with study of alternating electric currents.
2. In all atomic physics.
3. Vector quantities, viz. simple periodic variation, alternating voltages, forces such as encountered in steam turbine work.
4. Forms of the type $e^x - e^{-x} /2 = \cos \sqrt{-1x}$ are frequently encountered.
5. The motion of a fluid from a reservoir of indefinitely large size into a narrow restricted channel bounded by thin parallel

---

[1] To the following mathematicians the writer expresses thanks for their valued information so cheerfully given:

Bell, E. T.—California Institute of Technology
Berry, Wm. J.—Polytechnic Institute of Brooklyn
Doner, Ralph D.—Alabama Polytechnic Institute
Reese, R. H.—New Mexico School of Mines
Winn, C. C.—Detroit Institute of Technology

walls is represented by the function $Z=w-e^w$ in which $Z=x-yi$ and $w=u-vi$. (Here u and v are two real functions of the real variables x and y.)

6. If two long, straight parallel wires carrying electric currents of equal strength but opposite directions pass perpendicular to a given plane, the force function is $w=\log_e z-1/z-1$. In which w and z contain the imaginary unit, i as indicated in 5.

Systems of Linear Equations in Three or More Unknowns

1. Design of structural members.
2. Often used in mechanics where bridges are in spans or beams with several supports in getting reactions at various points of structure—three or more unknowns are common.
3. Used in connection with empirical data for finding a curve that may represent the data closely.
4. Needed to apply Kirchoff's laws to direct current in circuit nets.

Systems of Quadratic Equations

1. Hyperbola may be used to locate an enemy's gun or in range finding—an invisible source of sound.
2. In certain fundamental investigations connected with the theory of vacuum tubes it is necessary to find a solution of a differential equation. This solution involves a pair of quadratic equations.
3. Stresses involving design of crank-shafts, etc.

Graphs of Hyperbolas

1. Some use in route or railroad surveying.
2. Some curves in heat-power, as example $PV=e$.
3. In connection with any data (as in heat, etc.) where there is an exponential law.
4. In determining the orbits of comets.
5. In connection with Boyle's law. In this case, however, only that branch for which $PV>0$ has any physical significance.

Significance of Determinants

1. Essential to solve systems of linear equations.
2. Use in solving cubic equations and partial fractions.
3. Leads to matrices and matrix mechanics.

Roots of Cubic and Quartic Equations

1. In strength of materials. In flexure of beams cubic equations may appear. Oftimes graphic solution is satisfactory.

2. Used occasionally in third and fourth degree empirical formulae.

3. To secure reaction in continuous beams.

4. In electrical circuit work as done in telephone laboratories, the roots (especially the imaginary roots) of equations of degree eight and ten are of great use.

5. In order to solve problems of the type:

a. A sphere two feet in diameter is made of wood whose specific gravity is two thirds. Find the depth to which the sphere will sink.

b. Plotting the curve known as the folium of Descartes.

Inequalities

1. Restriction on parameters so certain conditions may be obtained.

2. To designate range of validity of formulae.

3. Showing where function is not equal to zero.

4. To determine range of convergence in expansion of functions.

5. Essential for the calculus without which nobody today can be a decent everyday engineer or electrician beyond the underpaid handbook hack working under a boss.

In contrast to the above more or less technical uses of algebra by specialists one should consider algebra as a universal short hand language used by scientists in many fields. Study of the scientific and cultural advances of civilization is rich with evidence of mankind's increased power over nature as man generally learned to use and manipulate symbols for spatial and quantitative concepts. Even though an individual is not planning to become a specialist in a field requiring vocational use of algebra he will have occasion to read and interpret articles, reports and stories using algebraic language. This use for algebra is perhaps not so obvious to the uninitiated in algebra but in the minds of forward looking educators it becomes a significant objective for the well educated citizen of tomorrow.

EXPERIMENTATION IN TEACHING CHEMISTRY

By Leonard A. Ford
Sioux Falls College, Sioux Falls, South Dakota

There is probably no method of classroom teaching and presentation in a beginning course in chemistry that is infallible. There are many variables such as time, place, subject matter, objectives, student individuality and teacher personality which tend to confuse rules universally applicable. Therefore, rules which could be formulated for the teaching procedure of one individual may not apply to another.

The methods employed by the teacher of chemistry will vary with his experience and the experience of others. It occurred to the author that one may adjust his procedure within certain limits to his own situation by means of a questionnaire in which the student was given an opportunity to express himself on the effectiveness of various methods used in the teaching of a beginning course in general chemistry. This is not to infer that student opinion should serve as a guide in teaching procedure, but it should indicate which of various methods aroused the greatest interest and which methods appeared dull and monotonous.

During the fall semester of 1937–1938, various teaching procedures were used in teaching a beginning class of 65 students in chemistry. These devices included lecture, with and without blackboard outlines, discussion, student reports, mimeographed outlines and questions, demonstrations, problems and examinations. At the end of the semester students indicated their reactions by filling out a questionnaire in which these devices were listed. They were asked to give their honest opinion with a view to making the course as helpful to them as possible. One may object to the questionnaire in that he may receive an undue amount of adverse criticism but teachers should welcome impersonal criticism. Furthermore, the privilege was not abused.

Students were asked: In which method do you learn more:

1. Lecture with blackboard outline.
2. Lecture with no blackboard outline.
3. No lecture with discussion and recitation only.
4. Lecture, blackboard outline and discussion.

Of the students responding to this question, 95% believed

they learned more by method number 4. The following answers are typical: "Blackboard clarifies," "it saves time," "distinguishes more important material," "facts observed as a whole rather than as a part," "discussion keeps the student on his toes," "makes note-taking easier," "learn by seeing as well as hearing."

In answer to the question "Do you learn more if you take notes?" 87% replied in the affirmative. Some of the reasons given were: "keeps my mind on the lecture," "cannot retain the material if I only listen," "act of writing seems to help me remember even if I don't look at my notes again," "permanent record for future use." When asked if the notes were readable and used again, typical answers were: "my notes are always readable," "use in reviewing for a test," "easier to understand than the book," "once I write something it is easier to remember." Three students indicated that they didn't use their notes and three believed "they were written too fast to be readable," "notes take my mind off the subject," "I prefer this method if I have plenty of time."

Mimeographed outlines and questions were regarded as being helpful by 87% of the students responding. Some typical replies concerning their value indicated: "give a more definite idea what should be learned," "I have a more definite idea what to study," "makes me study more," "know my lesson if I know answers to questions," brings out details I might overlook," "directs ones study," "keeps me from studying much useless material."

Other factors brought out by the questionnaire revealed that

1. Student-directed endeavors such as reports, projects and demonstrations were believed to be usually a waste of time.
2. Students worked harder if they had short daily and weekly examinations rather than longer six-week examinations.
3. Unit assignments were better than page assignments.
4. Informal lectures with opportunity for questions were more interesting than formal procedures.
5. Better work was believed to be accomplished by working alone in the laboratory than by working with a partner.
6. The practical side of chemistry, its applications, usefulness and relation to daily life did not receive sufficient emphasis.

The questionnaire is probably not a good test of the efficiency of the teaching technique but the results obtained here seem

to correlate with those obtained elsewhere from other types of investigation. However, the conclusions which one may reach from the questionnaire indicate that students are definitely more responsive to some methods than others.

Frequently we hear that the college and university chemistry teacher has lagged behind in modern methods of instruction. May this not be true because he does not appreciate the ability of the student to respond to his technique in teaching?

A questionnaire may reveal to the instructor that students are more responsive to certain methods than others, and that much better results may be obtained by varying the classroom procedure.

CONTOUR MAP OF LEWIS RIVER

A contour map of the Lewis River, Washington, from its junction with the Columbia River to a point 87 miles upstream has just been released by the Geological Survey, United States Department of the Interior. This map, made by the Geological Survey and the Inland Power & Light Co. in co-operation with the State of Washington, was surveyed on a scale of two inches to the mile, with contour intervals of 10 and 20 feet on land and five feet on the river surface. It shows the course of the stream, the contours of the valley bottom and immediately adjacent slopes, houses and roads, and large-scale plan of several dam sites. A part of the map was surveyed in 1928 prior to construction of the Ariel Dam and shows topography now submerged by the reservoir thus created, which has been named Lake Merwin.

The map provides an adequate base for stream utilization studies, especially to evaluate storage possibilities at several potential reservoir sites for power development, flood control, and navigation. This map may be consulted at the district office of the Geological Survey in the Federal Building, Tacoma, Washington, or may be purchased for 10 cents a sheet or $1 for the set of 10 sheets from the main office of the Geological Survey, Washington, D. C.

TECHNIQUES FOR TEACHING BIOLOGY

A committee of The Association of Biology Teachers of New York City has been gathering techniques concerned with the teaching of Biology. It is intended to publish these techniques, in the near future. Because of the nature of the work, it is hoped that teachers who read this announcement will contribute; these contributions will be credited to them upon publication. The book is not intended to deal with the theory of biology teaching but rather with the more practical aspects such as classroom demonstrations, methods of culturing and maintaining useful animals and plants, laboratory methods and other visual aids (excluding films, models and charts). Those desiring to contribute should send their manuscripts to P. F. Brandwein, either at the Department of Biology, New York University, New York City or at the George Washington High School, New York City, or to G. Schwartz, Richmond Hill High School, Richmond Hill, Queens, N. Y.

PROGRAM

Thirty-Eighth Convention Central Association of Science and Mathematics Teachers

November 25 and 26, 1938

LaSalle Hotel—Chicago

GENERAL PROGRAM

Friday Morning, November 25th, 9:45 A.M.

East Exhibit Hall, Mezzanine Floor

This program is of interest to teachers of science and mathematics in the elementary school, the junior and senior high schools, and the junior college.

"The Program In Science For 1950"
Dr. Morris Meister, Bronx High School of Science, New York, New York

"Recent Applications of Physics and Chemistry In Biology"
Dr. Francis O. Schmidt, Prof. of Zoology, Washington University, St. Louis, Missouri

"Josiah Willard Gibbs, An American Scientist and Mathematician"
Dr. Rudolph E. Langer, Professor of Mathematics, University of Wisconsin, Madison, Wisconsin

Friday Evening, November 25th, 6:30 P.M.

Red Room and Grand Ball Room, 19th floor—Reception, Annual Dinner, and Demonstration Lecture

The public is invited. This lecture is of interest to teachers of ***English, Speech, Music, Mathematics***, and ***Science*** at all school levels. Banquet $1.75, tax .06¢, tips and incidentals .19¢. Total cost of banquet ticket, $2.00.

Demonstration Lecture—"Words, Wires, Waves"
Dr. J. O. Perrine, Associate Editor, ***Bell System Technical Journal***, New York City, New York.

This lecture was made possible through the cooperation of the Illinois Bell Telephone System, assisted by G. M. McCorkle, Vice-President and L. W. Germain, General Superintendent of the Chicago Division, Long Lines Department of the American Telephone and Telegraph Company.

Send reservations for the Annual Dinner to Anna M. Olsen, Flower Technical High School, Chicago.

Saturday Morning, November 26th

8:00 to 9:00 A.M.—*Business Meeting*, East Room.

9:00 to 10:00 A.M.—*Demonstration Lecture*, East Exhibit Hall.

"How To Improve Science and Mathematics Teaching through Better Reading"
E. A. Taylor, American Optical Co., Southbridge, Massachusetts.

This program is of interest to teachers of all subjects at every school level.

10:00 A.M. to 12:00 Noon—*Four Group Meetings.*

Elementary School Group, Red Room, 19th floor.

D. W. Russell, presiding.

"Demonstration of a Radio Lesson in Elementary Science."
Mary Melrose, Supervisor of Elementary Science, Cleveland, Ohio

assisted by Veva McAtee, Supervisor of Science in Hammond, Indiana, and a class of pupils from the Hammond Schools.

Panel Discussion—Chairman, Paul G. Edwards, Director of Science and Visual Instruction, Board of Education, Chicago.

"New Trends In Elementary School Curricula, Especially Related to Science and Mathematics"

Panel—Louis M. Heil, Ohio State University, Columbus.
Clara Belle Baker, National College of Education, Evanston, Ill.
Ellis C. Persing, Western Reserve University, Cleveland.
Lillian Hethershaw, Drake University, Des Moines, Iowa.
Ralph B. Jones, Principal, Peabody School, Fort Smith, Arkansas.
Mildred Fahy, Principal, Peirce School, Chicago.

Junior High School Group, West Exhibit Hall, Mezzanine Floor.

T. J. Kuemmerlein, presiding.

"Science Concepts to be Taught in the Junior High School"
Dr. Morris Meister, Bronx High School of Science, New York City, New York.

"A Program For Conservation Education in the Junior High School"
B. J. Rohan, Sup't. of Schools, Appleton, Wisconsin and Guy Barlow, Principal of Wilson Junior High School, Appleton.

"Mathematical Concepts to be Taught in the Junior High School"
Dr. J. S. Georges, Wright Junior College, Chicago.

Senior High School Group, East Exhibit Hall, Mezzanine Floor.

Lillian Bondurant, presiding.

"Some Mathematical Concepts to be Taught in the Tenth Grade"
H. C. Christofferson, Prof. of Mathematics, Miami University, and President of the National Council of Teachers of Mathematics.

"Popular Beliefs That Are Not So"
W. W. Bauer, Director of the Bureau of Health and Instruction, American Medical Association.

"A Program In Science For All of The Pupils of The Senior High School"
Sherman R. Wilson, Head of the Science Department, Northwestern High School, Detroit, Michigan.

Junior College Group, East Room, Mezzanine Floor.

J. M. Kinney, presiding.

"The Desirability of the Understanding of Mathematical Concepts and Principles As a Preliminary Step to The Mastery of Manipulation and Technique"
O. M. Miller, Woodrow Wilson Junior College, Chicago.

"Some Aspects of Laboratory Work in General Chemistry"
Dr. H. I. Schlesinger, Prof. of Chemistry, University of Chicago.

"Attitudes Related To The Study of College Science"
P. P. Dewitt, Hanly Junior High School, University City, Missouri.

"The Function of Biological Science In General Education"
R. Clark Gilmore, Wright Junior College, Chicago, Illinois.

Section Meeting

Biology

Friday, November 25th, 2:00 P.M.

West Exhibit Hall, Mezzanine Floor

Officers

Lillian Bondurant, Chairman, Oak Park-River Forest Twp. High School, Oak Park, Illinois.
W. Harold Evans, Vice-Chairman, Hartwell High School, Cincinnati, Ohio
Esther D. Olson, Secretary, Kelly High School, Chicago, Illinois.

Program

This program is of interest to teachers of botany, biology, health, physiology, and zoology at all school levels.

Appointment of the Nominating Committee.

"The Development Of The Morton Arboretum" (Illustrated)
C. E. Godshalk, Superintendent of the Morton Arboretum, Chicago, Illinois.

"Fur Farming"
L. N. Silverman, President of The American Breeders Association.

"Biology Is Stranger Than Fiction"
John Y. Beaty, Author, Editor, Naturalist.

Election of Officers.

"New Materials and Equipment For The Teaching of Biology"
H. G. McMullen, University High School, Madison, Wisconsin.

Observation of Exhibits.

Chemistry

Friday, November 25th—2:00 P.M.
Room 104, Mezzanine Floor

Officers

Raymond R. Whitney, Chairman, Marshall High School, Chicago, Illinois.
Ernestine M. J. Long, Vice-Chairman, Normandy High School, St. Louis, Missouri.
Ray L. Harkins, Secretary, Woodward High School, Cincinnati, Ohio.

Program

Appointment of the Nominating Committee.

"The Wisdom of Attempting To Teach The Brönsted Nomenclature"
B. S. Hopkins, Prof. of Chemistry, University of Illinois.

"Experiences In Consumer Science Instruction"
M. C. Crew, Austin High School, Chicago, Illinois.

"Pupil Play-Around or Demon-Shaping Dictator"
H. R. Smith, Lake View High School, Chicago, Illinois.

"What Is Unfamiliar About The Familiar Tin Can"
L. G. Weiner, Chemist, American Can Company.

Election of Officers.

"New Materials and Equipment For The Teaching of Chemistry"
Open forum discussion.

Observation of Exhibits.

Elementary Science

Friday, November 25th, 2:00 P.M.
Red Room, 19th Floor

Officers

David W. Russell, Chairman, National College of Education, Evanston, Illinois.

Mary Melrose, Vice Chairman, Board of Education, Cleveland, Ohio.
Veva McAtee, Secretary, Rogers Clark School, Hammond, Indiana.

Program

Appointment of the Nominating Committee.
"How Should Science and Arithmetic Be Included In The Elementary School Curriculum"
Dr. Whit Brogan, Northwestern University, Evanston, Illinois.
Floor Discussion.
"Purposeful Activities and Functional Outcomes In Elementary Science"
W. C. Croxton, State Teachers College, St. Cloud, Minnesota.
Floor Discussion.
Election of Officers.
"New Materials and Equipment For Elementary Science"
Veva McAtee, Rogers Clark School, Hammond, Indiana.
Assisted By:
Helen Blough, Greeley, Colorado.
Peggy Cosmer, Battle Creek, Michigan.
Theodosia Hadley, Kalamazoo, Michigan.
Clara Heising, St. Louis, Missouri.
Marjorie Pratt, Milwaukee, Wisconsin.
Floor Discussion.
Observation of Exhibits.

SECTION MEETING

Geography

Friday, November 25th—2:00 P.M.

Room 103, Mezzanine Floor

Officers

Helen Turner, Chairman, Oak Park-River Forest Twp. High School, Oak Park, Illinois.
Fred J. Breeze, Vice-Chairman, North Side High School, Fort Wayne, Indiana.
Ethel Mills, Secretary, Soldan High School, St. Louis, Missouri.

Program

This program is of interest to teachers of geography and the social studies in the junior and senior high schools.

Appointment of the Nominating Committee.
"The Geography Teachers' Responsibility In Teaching Citizenship"
Dr. Edwin H. Reeder, Prof. of Education, University of Illinois.
"The Organization of Clubs In Geography"
Clare Symonds, High School, Quincy, Illinois.
"U. S. Highway 66—A Geographical Survey" (Illustrated)
Ethel Mills, Soldan High School, St. Louis, Missouri.
Election of Officers.
"New Materials and Equipment For The Teaching of Geography"
Mrs. R. W. Mikesell, Froebel School, Chicago, Illinois.
Observation of Exhibits.

General Science

Friday, November 25th—2:00 P.M.

Room 102, Mezzanine Floor

Officers

Theodore J. Kuemmerlein, Chairman, Boys Technical High School, Milwaukee, Wisconsin.
Herbert A. Grabau, Vice-Chairman, Lincoln High School, Des Moines, Iowa.
Pauline Royt, Secretary, Horace Mann Junior High School, West Allis, Wisconsin.

Program

This program is of interest to teachers of general science, health, hygiene, and physiology in grades seven, eight, and nine.

Appointment of the Nominating Committee.

"Demonstration Teaching—New and Old"
Dr. Morris Meister, Bronx High School of Science, New York City, New York.

"Superstitious Beliefs"
Rosalind M. Zapf, Cleveland Intermediate School, Detroit, Michigan.

"The Interests of the Child" (Illustrated)
Harold Stamm, High School, West Allis, Wisconsin.

Election of Officers.

"New Materials and Equipment for The Teaching of Science In The Junior High School"
L. H. Fuller, Boys Technical High School, Milwaukee, Wisconsin.

Observation of Exhibits.

Mathematics

Friday, November 25th—2:00 P.M.

East Exhibit Hall, Mezzanine Floor

Officers

Harold E. Spross, Chairman, Central High School, St. Louis, Missouri.
J. J. Urbancek, Vice-Chairman, Lake View High School, Chicago, Illinois.
Ida D. Fogelson, Secretary, Bowen High School, Chicago, Illinois.

Program

This program is of interest to teachers of mathematics at all school levels.

Appointment of the Nominating Committee.

"Functional Relationships In Elementary Algebra"
Prof. H. C. Christofferson, Miami University, and President of the National Council of Teachers of Mathematics.

"The Necessary and Sufficient Conditions In Elementary Mathematics"
Prof. Karl Menger, acting Chairman of the Department of Mathematics, University of Notre Dame. Formerly Professor of Mathematics, University of Vienna.

"Motivating High School Mathematics"
Charles M. Austin, High School, Oak Park, Illinois.

"Methods In Arithmetic and Algebra"
R. L. Short, Ashland Intermediate School, St. Louis, Missouri.

Election of Officers.

"New Materials and Equipment For The Teaching of Mathematics"

Bjarne Ullsvik, University High School, Madison, Wisconsin.

Observation of Exhibits.

Physics

Friday, November 25th—2:00 P.M.

East Room, Mezzanine Floor

Officers

James P. Fitzwater, Chairman, Lake View High School, Chicago, Illinois.

Ersie S. Martin, Vice-Chairman, Arsenal Tech High School, Indianapolis, Indiana.

Ray Lambert, Secretary, Walnut Hills High School, Cincinnati, Ohio.

Appointment of the Nominating Committee.

"Elementary Physics as a Cultural Course"

W. S. Webb, Prof. of Physics, University of Kentucky, Lexington, Kentucky.

"The Specialized Field Trip"

Haym Kruglak, Vocational School, Milwaukee, Wisconsin.

"How Can The Content And Teaching of Physics Courses Be Made More Functional?"

Dr. G. P. Cahoon, Ohio State University, Columbus, Ohio.

Election of Officers.

"New Apparatus and Materials For The Teaching of Physics"

A. H. Gould, Boys Technical High School, Milwaukee, Wisconsin.

Observation of Exhibits.

A Program By Exhibitors—Something New In Exhibits

The manufacturers of apparatus and equipment and the publishers of books contribute to the support of the Central Association by paying for advertising space in the Journal and in the Yearbook. The Association appreciates this support. In return the Association is anxious to support the exhibitors.

The exhibits will be continued this year as they have been in the past. The Association has provided a plan and place for exhibits which should prove satisfactory to all concerned.

There is no doubt that the development of new materials and new books has played an important part in improving our educational procedures. *But are we making all possible uses of these new products?* This year the Association has invited the exhibitors to take a vital part in the program of the Convention. This means that the advertisers are to be teachers as well as exhibitors. Several of the exhibitors have accepted this invitation and are making plans for giving lecture demonstrations on the uses and values of objective materials. These demonstrations will be educational in nature and will be given in the rooms used for the general and sectional meetings and at times which will cause no interference with these meetings.

The following list of demonstrations and lectures indicates how valuable and interesting this new feature is going to be. Plan your schedule so you can attend several of these lectures.

These Demonstrations will not be used to publicize the productions of the firms sponsoring them.

All Demonstrations and Lectures to be on Friday, November 25

GENERAL

Title: *Some Recent Researches in the Physical Sciences*
Time: 12:00 to 12:30 Place: East Exhibit Hall
Speaker: N. Henry Block
Sponsor: W. M. Welch Manufacturing Company
Title: *A Stump*
Time: 4:00 to 4:30 Place: East Exhibit Hall
Speaker: O. D. Frank
Sponsor: Geneva Lake Summer School of Natural Science

BIOLOGY

Title: *Methods of Visualizing Science*
Time: 9:00 to 9:40 Place: West Exhibit Hall
Speaker: E. V. Finnegan
Sponsor: Spencer Lens Company
Title: *Soilless Plant Culture*
Time: 12:30 to 12:50 Place: West Exhibit Hall
Speaker: A. S. Windsor
Sponsor: General Biological Supply House
Title: *Marine Animals in the Biology Laboratory*
Time: 12:50 to 1:15 Place: West Exhibit Hall
Speaker: A. S. Windsor
Sponsor: General Biological Supply House
Title: *Micro-Projection in Biology*
Time: 12:45 to 1:15 Place: Room 102
Speaker: H. W. Hollister
Sponsor: Bausch and Lomb Optical Company
Title: *Educational Preparations in Biology*
Time: 1:15 to 1:45 Place: West Exhibit Hall
Speaker: E. A. Baird
Sponsor: Chicago Apparatus Company
Title: *The Value of Anatomical Models in Visual Instruction*
Time: 4:00 to 4:20 Place: West Exhibit Hall
Speaker: M. G. Stowe
Sponsor: Denoyer Geppert Company
Title: *Teaching Functional Biology Through Adaptations*
Time: 4:20 to 4:45 Place: West Exhibit Hall
Speaker: Dr. Hilary S. Jurica
Sponsor: A. J. Nystrom and Company
Title: *A Demonstration of Sound Film: "Hunger"*
Time: 9:05 to 9:40 Place: East Exhibit Hall
Speaker: Dr. A. J. Carlson
Sponsor: University of Chicago Press

CHEMISTRY

Title: *Semi-Micro Chemistry*
Time: 4:00 to 4:30 Place: Room 104
Speaker: Warren C. Johnson
Sponsor: W. M. Welch Manufacturing Company

ELEMENTARY SCIENCE

Title: *Picture Technique in Elementary Science Teaching*
Time: 4:00 to 4:30 Place: Red Room, 19th Floor
Speaker: Dr. Verne O. Graham
Sponsor: A. J. Nystrom and Company

GENERAL SCIENCE

Title: *Simple Analyses of Aquarium Water*
Time: 4:00 to 4:30 Place: Room 102
Speaker: H. Sigler
Sponsor: Denoyer Geppert Company
Title: *Illustrating Elementary Astronomy*
Time: 4:30 to 4:45 Place: Room 102
Speaker: D. T. Stott
Sponsor: Denoyer Geppert Company

GEOGRAPHY

Title: *Geography Teaching Becomes Scientific*
Time: 9:10 to 9:40 Place: Room 103
Speaker: R. H. Redfield
Sponsor: A. J. Nystrom and Company
Title: *Visual Aids in the Teaching of the Social Sciences*
Time: 4:00 to 4:30 Place: Room 103
Speaker: Dr. Whit Brogan
Sponsor: Society for Visual Education, Inc.

PHYSICS

Title: *Demonstration of Film: "Sound Waves"*
Time: 12:45 to 1:15 Place: East Room
Speaker: D. P. Bean
Sponsor: University of Chicago Press
Title: *The Cathode Ray Oscillograph*
Time: 1:15 to 1:45 Place: East Room
Speaker: Russell Lund, Engineering Staff, Clough Brengle Co.
Sponsor: Chicago Apparatus Company
Title: *Polarized Light and Polaroid*
Time: 4:00 to 4:45 Place: East Room
Speaker: Dr. Kent H. Bracewell
Sponsor: Central Scientific Company

CONSTRUCTION SETS FOR MATHEMATICS STUDENTS

The Editor of SCHOOL SCIENCE AND MATHEMATICS receives frequent appeals from teachers of geometry and measurement for demonstration and illustrative materials to assist the student in visualizing mathematical propositions and problems. Recently Lafayette Instruments, Inc., 252 Lafayette Street, New York City has added to their line of instruments and models what seems to be the answer to these petitions. It is in the form of a model-construction set known as the Multi-Model Geometric Construction Set, which can be used for illustrating hundreds of problems in both plane and solid geometry, trigonometry, mechanical drawing, analytical geometry, science, etc. This construction set was developed by Dr. Herbert R. Hamley, Head of Mathematics of London Day Training College, an eminent British Authority on methods of teaching mathematics.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

1556. *Proposed by Mac Lipshitz, Bayonne, N. J.*

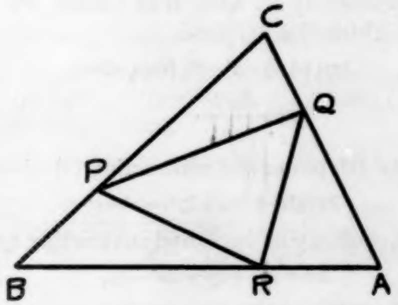
Locate on BC, CA, Ab, of triangle ABC the points P, Q, R, respectively such that

$$\frac{BP}{BC}=\frac{CQ}{AC}=\frac{AR}{AB}=\frac{1}{n}.$$

Show that the area of triangle

$$PQR=\frac{n^2-3n+3}{n^2} \text{ times area of } \triangle ABC, \text{ if } n \text{ is an integer.}$$

Solution by D. L. MacKay, New York, N. Y.



$\triangle BPR:\triangle ABC=(BR\cdot BP):(AB\cdot BC)=(n-1):n^2$, since $BP:PC=1:n$ and

$$BR:AB=(BA-AR):AB=1-\frac{1}{n}=\frac{n-1}{n} \text{ or } \triangle BPR=\frac{n-1}{n^2}\triangle ABC.$$

In like manner $\triangle$'s PQC and AQR bear the same ratio to $\triangle$ ABC.

$$\text{Hence } \triangle PQR=\triangle ABC-\frac{3(n-1)}{n^2}\triangle ABC=\frac{(n^2-3n+3)}{n^2}\triangle ABC.$$

It may be of interest to note that Pappus in his Collections Book VIII, prop. 2 showed that triangles ABC and PQR have the same center of gravity. See Paul ver Eecke, Pappus D'Alexandrie, vol. 2, 818. M. Charles in his Aperçu historique, 1889, p. 44, considered it a very remarkable proposition and stated that modern geometers have extended it to the polygon. F. J. Servois in his solution pean connues, p. 17, gave a solution for the special case when P, Q, R, are midpoints. Two solutions are given in Fuhrman's, Synthetische Beweis planimetrischer Sätze, 1890, p. 49.

Solutions were also offered by Sidney Cabin, M. H. S. of Aviation Tr. N. Y. C. Kenneth P. Carlson, Dannebrog, Nebraska, Charles W. Trigg, Los Angeles City College, and also by the Proposer.

1557. *Proposed by Charles W. Trigg, Cumnock College, Los Angeles.*

Find a square number of the form *abcdefgh* such that $gh=k(ab)$ and cd and ef are square numbers.

Solution by the Proposer.

There are 167 eight digit squares such that $gh=k(ab)$ Of these only 16 have ef a square number. Of these, only two have cd a square number, namely

$(3478)^2=12\ 09\ 64\ 84$, and

$(4813)^2=23\ 16\ 49\ 69$.

A solution was also offered by Sidney Cabin, New York City.

1558. *Proposed by Walter R. Warne, New York City.*

Eliminate x and y from the equations; (If possible, secure a solution involving no radicals at any place.)

$$x+y=a. \tag{1}$$

$$x^3+y^3=b^3. \tag{2}$$

$$x^4+y^4=c^4. \tag{3}$$

Solution by M. Kirk, West Chester, Pa.

Cubing (1) and subtracting (3) yield

$$3xy(x+y)=a^3-b^3, \text{ from which} \tag{4}$$

$$xy=\frac{a^3-b^3}{a}. \tag{5}$$

Raising (1) to the 4th power and subtracting (3) yields

$$2xy(2x^2+3xy+2y^2)=a^4-c^4. \tag{6}$$

By squaring (1), multiplying by 2, and subtracting xy,

$$2x^2+3xy+2y^2=2a^2-xy. \tag{7}$$

By substituting (7) and (5) in (6) and dividing

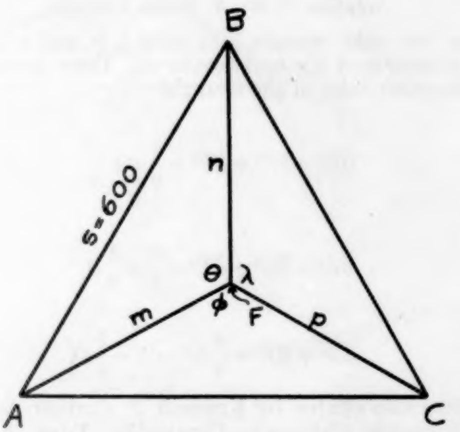
$$\frac{a^3-b^3}{a(a^4-c^4)}=\frac{3}{2(2a^2-xy)}\cdot \text{ By substituting (5) in (8)} \tag{8}$$

$$\frac{a^3-b^3}{a^4-c^4}=\frac{9a^2}{10a^3+2b^3} \text{ or } a^6-8a^3b^3-2b^6+9a^2c^4=0\cdot \tag{9}$$

Solutions were also offered by Norman Anning, Ann Arbor, Michigan, D. L. MacKay, New York, N. Y. Sidney Cabin M. H. S. of Aviation Tr. N. Y. C. Charles W. Trigg, Los Angeles City College, M. Freed, Wilmington California, and also by the Proposer.

1559. *Submitted by the editor.*

At the vertacis A, B, and C, of an equilateral triangle, each side being 600 ft. in length, towers a, b, c, with $a=30$, $b=40$, $c=50$ in height respec-



tively are erected. Where in the plane of the triangle must the foot of the ladder be placed, so that turning about its base, F, it will exactly reach the top of each tower. Also find the height of the ladder.

Solution by Charles W. Trigg, Los Angeles City College.

If from any point F in the plane of the equilateral triangle ABC with side s, lines m, n and p be drawn to the vertces and making angles θ, λ and ϕ with each other, then $\cos(\theta+\phi)=\cos\lambda$, so

$$\cos\theta\cos\phi-\cos\lambda=\sqrt{(1-\cos^2\theta)\ (1-\cos^2\phi)}. \tag{1}$$

By the laws of cosines, $\cos\theta=(m^2+n^2-s^2)/2mn$, $\cos\phi=(m^2+p^2-s^2)/2mp$, and $\cos\lambda=(n^2+p^2-s^2)/2np$. When these values are substituted in (1) and the equation is simplified,

$$m^4+n^4+p^4-(m^2n^2+m^2p^2+n^2p^2)-(m^2+n^2+p^2)s^2+s^4=0. \tag{2}$$

If perpendiculars a, b, c to the plane of the triangle be erected at the vertices, and if it be required that their tops all be the same distance, x, from F, then $m^2=x^2-a^2$, $n^2=x^2-b^2$, $p^2=x^2-c^2$. When these values are substituted in (2),

$$3s^2x^2=a^4+b^4+c^4+s^4+(a^2+b^2+c^2)s^2-a^2b^2-a^2c^2-b^2c^2. \tag{3}$$

When the particular values for this problem are substituted in (3), $x=\frac{1}{18}\sqrt{39420579}=348.81$ feet, $m=\frac{1}{18}\sqrt{39128979}=347.52$ feet, $n=\frac{1}{18}\sqrt{38902179}=346.51$ feet, $p=\frac{1}{18}\sqrt{38610579}=345.21$ feet. These values give the length of the ladder and locate F in the plane.

Solutions were also offered by W. R. Smith, Chicago, Ill., Walter R. Warne, New York City, N. Y., D. L. MacKay, New York, N. Y., Sidney Cabin, M. H. S. of Aviation Tr. New York City, N. Y. and Kenneth P. Carlson, Dannebrog, Nebraska.

1560. *Proposed by Dewey C. Duncan, Compton, Calif.*

Find the sum of the squares of the distances of the vertex of the right angle from the points of trisection of the hypotenuse. (See Altshiller-Court's *College Geometry*, page 114, problem 3.)

Solution by W. R. Smith Chicago.

Let ABC be any right triangle with sides a, b, and c. Let D and E be the points of trisection of the hypotenuse AC. Draw perpendiculars from D and E to the other sides of the triangle.

Then

$$\overline{BD}^2=\overline{BF}^2+\overline{DF}^2=\frac{4}{9}a^2+\frac{c^2}{9} \tag{1}$$

also

$$\overline{BE}^2=\overline{BG}^2+\overline{GE}^2=\frac{a^2}{9}+\frac{4}{9}c^2. \qquad 2)$$

By addition

$$\overline{BD}^2+\overline{BE}^2=\frac{5}{9}(a^2+c^2)=\frac{5}{9}b^2.$$

Solutions were also offered by Kenneth P. Carlson, Brule, Nebraska, M. Freed, Wilmington, California, Charles W. Trigg, Los Angles City College, D. L. MacKay, New York, N. Y., D. F. Wallace, Minnesota, Sidney Cabin, M. H. S. of Aviation Tr. N. Y. C., W. M. Gottschalk, Southborough, Mass., and also the Proposer.

1561. *Proposed by William W. Taylor, Port Arthur, Texas.*

In the triangle ABC, locate on AB the point M and on BC the point N such that MN has a given direction and is equal to the sum of MB and CN.

First Solution by the Proposer.

Construction: Through A', the midpoint of BC, draw the line DE perpendicular to the bisector of angle A. Since the triangle ADE is isosceles, construct the circle 0 tangent to the sides of angle A at the points D and E. Draw the line parallel to L touching the circle 0 in P and meeting the sides AB and AC in M and N, respectively. The line MN is the required line.

Proof: Since the triangle ABC is cut by the transversal DE, then by Menelaus' Theorem

$$\frac{BA'}{A'C}\cdot\frac{CE}{EA}\cdot\frac{AD}{BD}=1.$$

But,

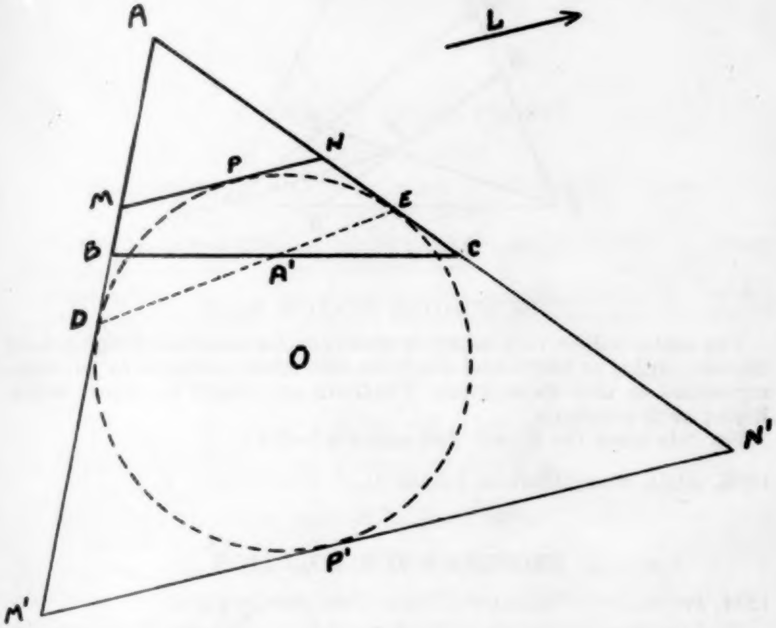
$$BA'=A'C \text{ and } EA=AD.$$

Then,

$$CE = BD$$
$$PM = MB + BD$$
$$PN = NE.$$

Therefore,

$$MN = MB + NC.$$



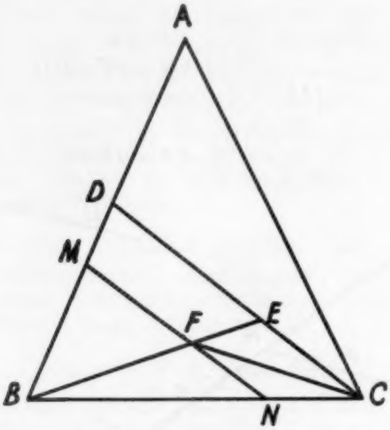
Note: If MN meets AB produced, then BM must be considered negatively. Furthermore it will be noted that $M'N'$ parallel to L and tangent to circle 0 satisfies the given conditions.

Second Solution, by D. F. Wallace.

Construction: Draw CD in the given direction meeting AB at D. On DC take $BE = DB$. Draw BE. Draw CF bisecting angle DCB, meeting BE at F. Through F draw MN parallel to CD, meeting AB at M and BC at N. Then MN has the required direction and is equal to the sum of MB and CN as required. (See drawing on following page.)

Proof: DBE is an isosceles triangle by construction ($MB = DE$) and because MF is parallel to DE, triangle MBF is similar to triangle DBE and is also isosceles, $MB = MF$. Because CD is parallel to MN, angle NFC = angle FCD, but angle FCD = angle FCN because CF bisects angle DCB. Therefore: Angle NFC = angle FCN. Therefore $FN = NC$. Therefore $MB + NC = MF + FN = MN$. MN has the required direction because it is parallel to CD which was drawn in the given direction.

Solutions were also offered by D. L. MacKay, New York, N. Y., Charles W. Trigg, Los Angeles City College, Sidney Cabin, M. H. S. of Aviation Tr., N. Y. C. Aaron Buchman, Buffalo, N. Y.



HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problms submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below:

1558. *Alvin Mars, Abraham Lincoln H. S. New York.*

PROBLEMS FOR SOLUTION

1574. *Proposed by William W. Tayler, Port Arthur, Texas.*

Find the locus of the midpoint of one side of a triangle if the opposite angle is fixed in position and magnitude and the sum of the including sides is constant.

1575. *Proposed by H. R. Mutch, Glen Rock, Pa.*

Solve in integers $x^2-7xy+y^2=z^2$.

1576. *Proposed by Norman Anning, University of Michigan.*

Prove that

$$\begin{vmatrix} x & 1 & 0 & 0 & 0\cdots \\ 1 & x & 2 & 0 & 0\cdots \\ 1 & 1 & x & 3 & 0\cdots \\ 1 & 1 & 1 & x & 4\cdots \\ 1 & 1 & 1 & 1 & x\cdots \\ \cdot & \cdot & \cdot & \cdot & \cdot\cdots \end{vmatrix} = \begin{vmatrix} x & 1 & 1 & 1 & 1\cdots \\ 1 & x & 1 & 1 & 1\cdots \\ 1 & 1 & x & 1 & 1\cdots \\ 1 & 1 & 1 & x & 1\cdots \\ 1 & 1 & 1 & 1 & x\cdots \\ \cdot & \cdot & \cdot & \cdot & \cdot\cdots \end{vmatrix},$$

the determinants being of the same order.

1577. *Proposed by Mary Foltz, Perry, Iowa.*

Given a circle with radius a, and a point p outside the circle at a distance $a+b$ from the center of the circle.

What is the locus of the midpoints of segments p to farther arc of the circle and also to the nearer arc?

1578. *Proposed by S. Afpisain, Lucknow, India.*

Construct a quadrilateral $ABCD$ having given all the angles, diagonal AC and that the diagonals intersect at right angles.

1579. *Proposed by Hugo Brandt, Chicago, Ill.*

If $\dfrac{t(3-t^2)}{1-3t^2}=\sqrt{3}$ and $W=\sqrt{t^2+1}$ and if $W_0^2(W_0+6)=8$, then $W=W_0$.

SCIENCE QUESTIONS

November, 1938

Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio

Readers are invited to co-operate by proposing questions for discussion or problems for solution.

Examination papers, tests, and interesting scientific happenings are very much desired. Please enclose material in an envelope and mail to Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio.

DO YOU KNOW THE ANSWERS?

11. Who devised the first sub-marine and when?
Was it ever used?
12. What inventions were forecast by Jules Verne?
Name the books.
13. Who was "the patron saint of Alchemists"? Why so-called?
14. How "drive in darkness" with your headlights turned on?
15. Have you an interesting or instructive question to propose to the SCIENCE QUESTIONS DEPARTMENT? (If so, it will get you into the GQRA. More than 250 others are already in.)

GQRA—NEW MEMBERS, November, 1938

252. Hazel C. Jones, Danville, Ill.
253. Edith Fohey, Mercy High School, Milwaukee, Wis.

GENERAL SCIENCE FINAL

847. *Proposed by Leo R. Spogen, GQRA No. 64, Carbon County High School, Red Lodge, Montana.*

1. A boy five feet from a 100-candle power light would receive how many foot-candles of light? ________
2. To make my knife blade a north pole I would rub it on a ________.
3. The end of a magnet that would repel the north end of a compass is a ________, ________.
4. The magnetic variation of Red Lodge is ________.

5. Lode stone is a __________.
6. In electroplating the metal always deposits on the __________.
7. I would make a charge of plus electricity by rubbing __________.
8. Name four uses of the electromagnet __________, __________, __________, __________.
9. The lightning rod works by discharging into the air __________.
10. The three chemicals in a storage battery are __________, __________, __________.
11. A coil of wire is revolved in a magnetic field—
    What kind of current is formed? __________.
12. How long could you burn a 50 kilowatt lamp if electricity cost 8 cents per kilowatt hour? __________.
13. The wire used in an electric iron is __________.
14. The wire used in electric lights is __________.
15. If a plus charged cloud goes over the earth, the earth will be charged __________ minus by __________.
16. Which color is bent most by a prism? __________.
17. A book looks green because __________.
18. Give colors that make white light in their order in the spectrum __________.
19. Persistency of vision makes possible __________.
20. C an octave higher than middle C vibrate __________.
21. The wave length of KOA which broadcasts on 850 kilocycles is __________.
22. The part of a vacuum tube that produces electrons is the __________.
23. To test for an acid I would use __________.
24. The sensitive part of a transmitter that makes the current large or small is the __________.
25. Give an example of the third class lever __________.
26. Sour milk contains what acid? __________.
27. How much force will it take to push a 600 lb. barrel up a 12 foot plank to a platform 2 feet high? __________.
28. A force moves ten times farther than the weight. The force is 50 lbs., What is the weight? __________.
29. On the explosion stroke of an automobile what is the position of the valves? __________.
30. What minerals are exhausted from the soil and should be replaced? __________.
31. Mountains are formed by the __________.
32. Were the Bear Tooth Mountains always here? __________.
33. Strata appear in what kind of rocks? __________.
34. Red Lodge Valley was cut out by __________.
35. The infant plant is fed during infancy __________.
36. "Rag-doll" tester is used in the __________.
37. Name three proteins __________, __________, __________.
38. Name three carbohydrates __________, __________, __________.
39. What do we usually have too much of in our diet? __________.
40. How can most of us secure better balanced diet? __________.
41. Ricketts is caused by lack of __________.
42. Beri-beri is caused by lack of __________.
43. What does mammal mean? __________.
44. Name the five classes of vertebrates __________.
45. The material on a kodak film that is sensitive to light is __________.
46. and 47. How do seeds reproduce? __________.
48. What part of the U. S. is sinking? __________.
49. and 50. By diagram show how a convex lens magnifies. __________.

BRAIN TEASER NO. 837—CROSS WORD PUZZLE

Horizontal

1. Insects.
2. We see with them.
3. To annoy.
4. You should solve this puzzle with this but probably won't.

Vertical

1. Dogs do it.
2. So do snakes.
3. A large one is a mouthful.
4. Puzzles delight when their victims do it.

Solution by Hazel C. Jones, Danville Illinois. (Elected to GQRA, No. 252)

	1.	2.	3.	4.
1.	*b*	*b*	*b*	*b*
2.	*i*	*i*	*i*	*i*
3.	*t*	*t*	*t*	*t*
4.	*e*	*e*	*e*	*e*

"*Did you do it on this puzzle?*" [*Ed.*]

BOOKS AND PAMPHLETS RECEIVED

Theory of Equations, by Joseph Miller Thomas, Professor of Mathematics, Duke University, Durham, North Carolina. Cloth. Pages x+211. 13.5×20.5 cm. 1938. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.00.

Algebra for Today, Second Course, by William Betz, Vice-Principal of the East High School and Specialist in Mathematics for the Public Schools of Rochester, New York. Cloth. Pages xii+518. 12.5×19 cm. 1938. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price $1.36.

A New Geometry, by A. W. Siddons, Late Fellow of Jesus College, Cambridge; late Senior Mathematical Master at Harrow School, and K. S. Snell, Late Scholar of Trinity College, Cambridge; Senior Mathematical Master at Harrow School. Cloth. Pages xvi+302. 13×19 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.32.

Adventures with Living Things, by Elsbeth Kroeber, Chairman, Department of Biology, James Madison High School, New York City, and Walter H. Wolff, Chairman, Department of Biology and General Science, DeWitt Clinton High School, New York City, also Instructor School of Education College of the City of New York. Cloth. Pages xiii+798. 13.5×20.5 cm. 1938. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $1.96.

Color Photography for the Amateur, by Keith Henney, Editor of *Electronics*; Author of "Principles of Radio" and "Electron Tubes in Industry," Editor of *Radio Engineering Handbook*. Cloth. Pages x+281. 14×20.5 cm. 1938. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $3.50.

Laboratory Manual and Problems for Elements of Statistical Method, by Albert E. Waugh, Professor of Economics, Connecticut State College.

Cloth. Pages x+171. 15×23 cm. 1938. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $1.50.

Methods and Materials for Teaching Biological Sciences, by David F. Miller, Associate Professor of Zoology and Supervisor of Teacher Training in the Biological Sciences, The Ohio State University, and Glenn W. Blaydes, Associate Professor of Botany, The Ohio State University. Cloth. Pages xii+435. 14.5×23 cm. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $3.50.

The Magic Wand of Science, by Eugene W. Nelson. Cloth. 213 pages. 12.5×19 cm. E. P. Dutton and Company, Inc., 300 Fourth Avenue, New York, N. Y. Price $2.00.

Review Course in Algebra, by W. E. Sewell, Assistant Professor of Mathematics, Georgia School of Technology. Cloth. Pages v+143. 13×20 cm. 1938. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $1.20.

Plane Trigonometry, by George M. Hayes, Assistant Professor of Mathematics, College of the City of New York, and Murray J. Leventhal, Chairman, Mathematics Department, James Madison High School, Brooklyn, N. Y. Cloth. Pages vii+248. 13×20 cm. 1938. Globe Book Company, 175 Fifth Avenue, New York, N. Y. Price $1.60.

Analytic Geometry and Calculus, by Frederick S. Woods and Frederick H. Bailey, Professors Emeriti of the Massachusetts Institute of Technology. Cloth. Pages xi+524. 13.5×21 cm. 1938. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price $4.00.

Medieval Number Symbolism, Its Sources, Meaning and Influence on Thought and Expression, by Vincent Foster Hopper, Assistant Professor of Literature, New York University, School of Commerce, Accounts and Finance. Cloth. Pages xii+241. 14×21.5 cm. 1938. Columbia University Press, 2960 Broadway, New York, N. Y. Price $2.90.

Bacteriology, by Estelle D. Buchanan, Formerly Assistant Professor of Botany, Iowa State College, and Robert Earle Buchanan, Professor of Bacteriology, Iowa State College and Bacteriologist of the Iowa Agricultural Experiment Station. Fourth Edition. Cloth. Pages xv+548. 13.5×21 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $3.50.

Readings in Elementary Organic Chemistry, Edited by L. A. Goldblatt, University of Pittsburgh. Paper. 150 pages. 20×27.5 cm. 1938. D. Appleton-Century Company, 35 West 32nd Street, New York, N. Y. Price $1.25.

New Tests and Drills in First Course Algebra, by Walter W. Hart, Author of Wells and Hart Texts in Secondary Mathematics. Paper. 91 Tests. 20.5×26 cm. 1938. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price 40 cents.

A Manual for the Biology Laboratory, by Perry D. Strausbaugh, Professor of Botany, West Virginia University, and Bernal R. Weimer, Professor of Biology, Bethany College, West Virginia. Paper. Pages ix+183. 21.5×28 cm. 1938. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $1.75.

Science Problems, Book I, by Wilbur L. Beauchamp, The University of Chicago; John C. Mayfield, The University High School, Chicago, Ill.; and Joe Young West, Maryland State Teachers College, Towson, Maryland. Cloth. Pages xi+432. 14×21 cm. 1938. Scott, Foresman and Company, 623 South Wabash Avenue, Chicago, Ill. Price $1.28.

Discovering Our World, Book II, by Wilbur L. Beauchamp, Glenn O. Blough and Mary Melrose. Cloth. 352 pages. 13×19 cm. 1938. Scott,

Foresman and Company, 623 South Wabash Avenue, Chicago, Ill. Price 96 cents.

Yellowstone Through the Ages, by Arthur D. Howard, Ph.D. Paper. 62 pages. 13×18.5 cm. 1938. Columbia University Press, 2960 Broadway, New York, N. Y. Price 50 cents.

The Chemical Organization of Living Matter, by C. F. Krafft. Paper. 27 pages. 15×23 cm. 1938. Carl F. Krafft, 2510 Q Street, N.W., Washington, D. C.

One Hundred Problems in Consumer Credit, by Charles H. Mergendahl, Head of the Mathematics Department, Newton High School, Massachusetts Instructor, Harvard University Summer School, and Le Baron R. Foster, Associate Director, Pollak Foundation for Economic Research. Pollak Pamphlet, Number 35. 55 pages. 13.5×19.5 cm. April, 1938. Pollak Foundation for Economic Research, Newton, Mass. Price 10 cents.

World-Time Indicator, A Gadget to Determine the Time Prevailing at Any Locality in the World, and to Determine the Time at which a Distant Radio Broadcast or other Event will be Heard at Your Locality, by E. Lyford, and A. A. Ghirardi. 12.5×18.5 cm. 1938. Radio and Technical Publishing Company, 45 Astor Place, New York, N. Y. Price 50 cents.

The School Building Situation and Needs, by Alice Barrows, Senior Specialist in School Building Problems. Bulletin 1937, No. 35. vi+62 pages. 15×23 cm. United States Department of the Interior, Office of Education, Washington, D. C. Price 10 cents.

Statistics of City School Systems, 1935–1936, by Lester B. Herlihy, Associate Specialist in Educational Statistics, and Walter S. Deffenbaugh, Chief, Division of American School Systems. Bulletin, 1937, Number 2. Pages iv+77. 14×23.5 cm. Superintendent of Documents, Washington, D. C. Price 10 cents.

Statistics of State School Systems, 1935–1936. Prepared by David T. Blose, Associate Specialist in Educational Statistics, and Henry F. Alves, Senior Specialist in State School Administration. Bulletin, 1937, No. 2. Pages vi+126. 14×23.5cm. Superintendent of Documents, Washington, D. C. Price 15 cents.

Electric Power Statistics, 1937. May 1938. Paper. 19×27 cm. Federal Power Commission, Washington, D. C.

Development of Sight-Saving Class Work in the Fairhill School, Philadelphia, by M. Reba Sprowles, Principal, Fairhill School, Philadelphia, Pa. Reprinted from *The Sight-Saving Review*, Vol. VII, No. 4, December, 1937. 11 pages. 15×23 cm. National Society for the Prevention of Blindness, Inc., 50 West 50th Street, New York, N. Y. Price 10 cents.

Swimming and Diving, prepared by the American Red Cross. Paper. 67 Illustrations. Pages ix+271. 12.5×19.5 cm. 1938. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price 60 cents.

The Conservation Handbook for Massachusetts 4-H Club Leaders, prepared by William G. Vinal, Professor of Nature Education, Amherst College, Amherst, Mass. Paper. 11 pages. 21×28 cm. Massachusetts State College, U. S. Department of Agriculture and County Extension Services, Amherst, Mass.

Catalog No. 6, by the Chemical Publishing Company. Paper. Pages 126+xx. 13×21 cm. Chemical Publishing Company, 148 Lafayette Street, New York, N. Y. Price 10 cents.

Portrait of Pythagoras from a Fresco, by Raphael. 25.5×35 cm. A free copy of the Portrait of Pythagoras, suitable for framing may be obtained by writing to Scripta Mathematica, 186th Street and Amsterdam Avenue, New York, N. Y., and enclosing 6 cents in stamps for postage.

BOOK REVIEWS

Introductory General Chemistry, by Stuart R. Brinkley, Associate Professor of Chemistry, Yale University. Revised Edition. Pages x+731. 22×15.5 ×4 cm. 175 figures and several full page portraits. Cloth. 1938. Macmillan. $3.50.

Some six years ago we wrote a very complimentary review of the predecessor of this revised text and it is again going to be necessary to repeat our praises. Not the least of the admirable features of the book is the consistent presentation of the fundamental facts before attempting to give an account of the theories which have been devised to account for or to correlate the facts. A sampling of the sections which present some of the newer ideas of physical chemistry shows that discretion has been used, in that no attempt has been made to overdo the matter, only enough of the factual basis having been given to make the theoretical explanation understandable.

Much new material of a descriptive nature has been added as well as a very considerable amount of work on qualitative analysis. As the author suggests in his preface no teacher has to try to use all the matter presented in the text and if the earlier part of the book is used fully there will be no difficulty in cutting out as much of the subsequent sections as may be desired. The treatment of the principles involved in the qualitative separation of the metallic ions is admirable, especially the discussion of the regulation of the concentration of ions and the effects of hydrolysis and of the formation of complexions.

The sections on industrial chemistry have been well brought up to date (a rather unusual feature in a chemistry text book, as will become quite apparent to anyone who will take the trouble to look up the commercial preparation of metallic sodium in the first 57 text books that he comes across and then ask the Du Pont Co. how their Niagara Falls plant now produces it! ! ! ! !).

FRANK B. WADE

Chemistry at Work, by William McPherson, William Edwards Henderson, both Professors of Chemistry in the Ohio State University, and George Winegar Fowler, Supervisor of Science, City Schools, Syracuse, New York and Instructor in the Methods of Teaching Science, School of Education, Syracuse University. First Edition. Pages x+672. 3.2×16.3 ×23.3 cm. 471 figures and several full page plates. Ginn & Co. Cloth. 1938. $1.80 with usual discount.

As will be noted by those who scan the dimensions above, this is a big book for a high school student to carry around with him. However, on looking it over, we find that the size is due very largely to the abundance of illustrations (which the authors deem very valuable to the beginning student) and to various other space taking arrangements of material rather than to the inclusion of too many units.

In the matter of units the writers have very definite ideas as to the undesirability of carving up a connected science just to get what may pass for units. While they think that a unit type of arrangement is possible and desirable in the introductory portion of the book they do not propose to cripple themselves by slavishly adhering to strict unit type development of the rest of the book.

Although the names of two of the authors are and have long been well and favorably known to chemistry teachers as writers of excellent texts this book is really a new book and not a revision of any previous text. Between the lines one can see much of application of modern educational

psychology to the art of teaching chemistry, and perhaps the junior author could be suspected in this matter.

Being in the act of trying to teach subatomic structure in its elementary phases the reviewer sampled the text at this point and found it excellent and acceptable to his students. A glance at the method of teaching the Avogadro Law and its implications and applications show a clear and logical presentation with the Gay Lussac Law as the natural antecedent.

The industrial chemistry seems to be up to date (or as nearly so as can be expected in a text book in so rapidly growing a subject as chemistry). Metallic sodium, for example, is not made by electrolyzing melted sodium hydroxide, but from fused sodium chloride (with suitable additions).

May we suggest to high school teachers of chemistry that a look at this text will prove suggestive.

FRANK B. WADE

Van Nostrand's Scientific Encyclopedia, by Authorities in Each Field of Science. Contributing Editors: Geology—Richard M. Field, Ph.D., Princeton University; Astronomy and Navigation—Warren K. Green, Ph.D., Amherst College; Zoology—Arthur W. Lindsey, Ph.D., Denison University; Engineering and Aeronautics—Frederick T. Morse, M.E., E. E., University of Virginia; Medicine—R. S. Mueller, M.D., Columbia University; Mathematics—Lloyd L. Smail, Ph.D., Lehigh University; Mineralogy—Edward S. C. Smith, S.B., A.M., Union College; Chemistry—Ralph K. Strong, Ph.D., Rose Polytechnic Institute; Physics—Le Roy D. Weld, Ph.D., Coe College; Botany—R. M. Whelden, Ph.D., Massachusetts Inst. of Technology. Among the many Consulting Editors were the following: Robert H. Baker, Ph.D., D.Sc., University of Illinois; Hempstead Castle, Ph.D., Yale University; C. W. Cunningham, B.S., College of the City of New York; Herbert O. Elftman, Columbia University; Erich Hausmann, E. E., Sc.D., Polytechnic Inst. of Brooklyn; Adolph Knopf, Ph.D., Yale University; John C. Rathbun, Ph.D., College of the City of New York; Edgar P. Slack, S.B., Polytechnic Institute of Brooklyn; Hugh S. Taylor, D.Sc., F.R.S. Princeton University; John Turkevich, Ph.D., Princeton University; Volney H. Wells, Ph.D., Williams College. Buckram. Pages 1234. 15×23 cm. 1938. D. Van Nostrand Company, Inc., New York, N. Y. Price $10.00.

This Encyclopedia covers the basic sciences of chemistry, physics, mineralogy, geology, botany, astronomy and mathematics; the applied sciences of navigation, aeronautics and medicine; and the three branches of engineering—civil, mechanical and electrical. It is truly, as the prospectus says "12 books in one." Its 1234 pages contain 1500 illustrations, 10,000 articles, and over 2,000,000 words. Ten thousand terms of scientific interest are arranged alphabetically and an extensive system of cross-indexing permits the reader to turn without delay from any term not expanded in full to the article where the complete information may be found. For instance, under "Bunting" is a brief description of "birds related to the finches and sparrows." In the description the word for "the painted bunting" is given as "nonpareil." On turning alphabetically to "nonpareil" the reader is referred back to "bunting" for a complete brief discussion. This has been tested out by the reviewer in a number of cases always with success in finding the information desired.

Words are not wasted in the expansion of the topics and yet the articles are surprisingly satisfactory in the exactness and completeness of the information contained. Under "oxygen" the first paragraph gives the physical and chemical constants such as Symbol, Atomic number, Atomic

weight, Density, Formula of oxygen gas (also Ozone), Melting point Boiling point, Critical temperature, and Critical pressure. If a teacher had a copy of this book on his desk, he could save much class time and also give his pupils invaluable experience in the proper use of a reference book. There follows the topic more than two full columns of information together with a complete page-and-a-third in tabular form of certain oxygen-function compounds.

It has been, of course, impossible to read all of a book of this kind but sample readings have indicated its comprehensiveness, understandability, and accuracy. To the teacher, general reader and pupil it will prove a time-saver of great importance; to the expert in any branch of the subjects covered it will be very valuable in giving him a quick check-up of information on the subjects outside his specialty.

The claims of the pre-publication prospectus and the Preface of the work itself are fully substantiated by an examination of the book.

The publishers have offered a convenient instalment method of purchase which takes the shock off the total price. Interested readers may inquire of the publishers for details. The price is no obstacle to libraries, particularly school and departmental libraries, and all should possess a copy. The instalment purchase plan puts it easily within the reach of individual instructors. Recommended.

FRANKLIN T. JONES

Starcraft, by William H. Barton, Jr., Executive Curator, Hayden Planetarium, New York City, and Joseph Maron Joseph, Head, Science Department, Smedley Junior High School, Chester, Pennsylvania. Cloth. Pages vii+288. 15×23 cm. 1938. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $2.50.

Starcraft is a guide for beginning students of the stars. A special description of each of the principal constellations is given with a picture map and a diagram to show its altitude and direction. In each case there is a paragraph telling what can be seen with the naked eye, one telling additional details visible through an opera glass, and one telling what is revealed by a small telescope. Some of the special features are: (1) tables giving the positions of the four most prominent planets for the four years from 1938 to 1941; (2) fifteen short human interest stories of great astronomers; (3) a chapter of "Do you know?" questions; (4) a guide to the pronunciation of astronomical names given with the index.

The book is also a construction manual. It gives directions for making such instruments as the quadrant, sextant, sundial, etc. An entire chapter is used to give detailed instruction for making a reflecting telescope for amateur use.

This book is perfectly reliable in subject matter, elegantly illustrated, and intensely interesting and attractive.

G. W. W.

Radio, A Study of First Principles, by Elmer E. Burns, Instructor in physics, Austin High School, Chicago. Third Edition. Cloth. Pages xvi+293. 13.5×20 cm. 1938. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $2.00.

This is the third edition of a book that has held an enviable place for the past ten years. It is the best radio text on the market for high school and evening classes that have had no basic work in electricity and mathematics. By skillful use of good diagrams and clear, simple descriptions the author succeeds in making intelligible to inexperienced students many of the intricate ideas of the science of radio such as inductance, capacitance,

tuned circuits, amplification, modulation—in fact almost everything about the elements of radio. This new edition explains the operation and uses of all the latest tubes, automatic volume control, the three types of amplification, short wave operation, and the latest developments in television.

G. W. W.

Introductory Qualitative Analysis, by Warren C. Vosburgh, Professor of Chemistry at Duke University. Cloth. Revised edition. Pages vii+222. 15×22 cm. 1938. The Macmillan Company, New York. Price $2.25.

"This book is a revision and enlargement of a book of the same title written by D. Jacob Cornog and the present author. The present book is adapted to a one-semester course in qualitative analysis, and as before, the chief emphasis is on instruction in chemical principles and the scientific method rather than on the teaching of an immediately practical art."

Part I has to do with laboratory work and Part II discusses the theory. The laboratory portion consists of a chapter listing sixteen exercises starting with the construction of apparatus, followed by filtration, washing precipitates, group separation and the analysis of the various groups of cations and anions. The last two exercises deal with the analysis of a mixture of salts and the analysis of an industrial product or mineral. Chapter III describes the systematic analysis of the cations, Chapter IV the systematic analysis of the anions and Chapter V the analysis of solid materials. Directions for semi-micro technique parallel the macro directions.

Preliminary experiments on the chemistry of individual ions are not included. To the reviewer this would be a distinct handicap in teaching the general principles of qualitative analysis.

The Lowry-Bronsted conception of acid-base equilibria is used in the theoretical portion. One notices with satisfaction the elimination of the hypothetical ammonium hydroxide molecule. Most of the illustrative equations for reactions in solution are written ionically rather than molecularly which makes for simplicity. The derivation of the solubility product constant is probably as rigorous as is desirable in an introductory course. The ion-electron method of balancing oxidation-reduction equations is illustrated in the last chapter.

Numerical problem exercises are listed at the end of each chapter of Part II. An appendix and index are included. This book merits the attention of teachers in liberal arts colleges.

Druley Parker

Physics of Today, by John A. Clark, Chairman of the Standing Committee on Science for the Public High Schools of New York City, Frederick Russell Gorton, Head of the Department of Physics and astronomy, Michigan State Normal College, and Francis W. Sears, Assistant Professor of Physics, Massachusetts Institute of Technology. Cloth. Pages vi+633. Size 3.6×14×20 cm. 750 figures. 1938. Houghton Mifflin Co. $1.80.

From a physical aspect alone the text should prove an inspiration to the high school student of physics. It is, moreover, well organized and strives for simplicity and clearness. The twenty-three chapters are grouped in nine units and each unit is introduced by a preview that aims to give the student a brief, stimulating glimpse of the subject matter. A few short guidance questions preface each chapter while summaries and both old- and new-type questions close them. A reasonable number of problems of both the qualitative and quantitative variety are given. They appear to be well chosen and suitable for the average student who usually shows no great agility in algebra when we get him.

The book is replete with fine and unusual illustrations. In particular, the chapters on light are superbly done in this respect. It is, altogether, a fine modern text and well worth your acquaintance.

A. H. GOULD

Clear Thinking, an Approach Through Plane Geometry, by Leroy H. Schnell, State Teachers College, Indiana, Pennsylvania, and Mildred Crawford, Roosevelt School, Michigan State Normal College, Ypsilanti, Michigan. First Edition. Cloth. Pages xviii+439. 15×23 cm. 1938. Harper and Brothers, 49 E. 33rd Street, New York, N. Y. Price, $1.60.

This book is a serious attempt to shift emphasis in the study of geometry from formal learning to the development of the ability to think independently. The authors have tried to center attention first on careful thinking and then have gone on to a study of geometry. For example, in the first 24 pages of the text there is nothing that could be classified as mathematics. The authors take the pupils into their confidence, telling them that the important thing is learning to think, explaining in general how this is done and leading them to think carefully through some non-geometrical situations. Then very informally and slowly basic constructions are studied to learn how to do them and to think about them. The writers have been very careful to hold to what they believe to be the pupils' level of ability and interest. Even the vocabulary is often that with which the pupils are already familiar. For example, one finds such expressions as "hunch," "catchy," "tip," "Barnum's bromide," "follow the Pied Piper," "thin skinned people," "skipping school so he won't catch it," "curiosity killed a cat."

The authors seem to regard concise definitions as too formal, because important word meanings are often merely implied, or are put in parentheses in the middle of a sentence, or printed in foot notes. Care in avoiding imposing the authors' ideas on the pupils is sometimes carried to the extent of inviting pupils to "devise a method" for a construction that is quite new to him. Tests to determine whether the pupil has done what he set out to do in a construction are not always suggested in the introductory work.

In line with the authors' purpose to develop the ability to think in non-geometrical situations, they frequently introduce such subjects as the value of curiosity, lynching, illiteracy, traffic accidents, etc. There is a note recommending that pupils read "And Sudden Death."

The book contains no numbered articles, there are no reviews, no tests, and relatively few exercises. The text contains all propositions usually included in Plane Geometry and probably has sufficient material for a year's course. The sequence varies somewhat from that usually followed in such texts. Like some English texts, the book has many unfilled pages, an unprinted inch or two being left at the bottom of the page. On the whole the book is an interesting experiment consistently carried through.

WALTER H. CARNAHAN

Intermediate Algebra, by W. E. Brooke, Head of the Department of Mathematics and Mechanics, and H. B. Wilcox, Professor of Mechanics, Institute of Technology, University of Minnesota, Minneapolis, Minnesota. First Edition. Cloth. Pages viii+323. 15×22 cm. 1938. Farrar and Rinehart, New York, N. Y. Price $1.90.

The authors of this book have observed an ever widening gap between the algebra of the high schools and the mathematics of the first college year, and this book is an attempt to close up this gap. They have held firmly to the purpose to avoid writing another second course in high school

algebra or another college algebra. They have throughout the book tried to build up a firm logical understanding of the fundamentals of elementary algebra. To this end they have introduced technical language and have formally proved theorems that the student has previously been expected to accept on the basis of illustration or intuition.

At first the exercises are very easy, and throughout the problems are neither so numerous nor so difficult that attention is forcibly diverted from the main purpose of the text to mere problem solving. The book is divided into lessons which are fifty-four in number. There are many solved examples for the guidance of students. No answers are given. Common errors are pointed out and discussed with illustrations.

Among the topics treated are determinants, progressions, variations, exponents and sets of equations, as well as more elementary subjects. There is a method for the calculation of logarithms. Students taking this course will unquestionably be well prepared for all future study of mathematics.

WALTER H. CARNAHAN

A Short Course in Trigonometry, by James G. Hardy, Professor of Mathematics in Williams College, Williamstown, Mass. Revised Edition. Cloth. Pages ix+143. 14.5×22 cm. 1938. The Macmillan Company, New York, N. Y. Price $2.25.

This is an elementary text so written that all ordinary difficulties of students of trigonometry are anticipated and prepared for by presenting all facts and principals on which the new ideas are dependent. The author begins with as few assumptions regarding previously mastered facts as possible and develops the subject by easy steps some of which make an appeal to the students' intuition. The language is not over technical but for the most part makes use of terms with which every one can be expected to be familiar. The author does not introduce all six common trigonometric ratios at the beginning, but first takes up sine, cosine and tangent for definition and application then introduces the other three for similar treatment. And throughout the book, difficulties are introduced one at a time and carefully treated.

There is an abundance of exercises and problems, many of which are well within the ability of students who will not care to study mathematics as a major subject. Throughout the book are remarks on method which will undoubtedly smooth the way for many students. There are many chapter reviews which will make it easy for the instructor to check on the degree of mastery of the unit.

Solution of oblique triangles is introduced early, and analytic trigonometry is begun sooner than in most texts. Graphs and variations are very extensively treated. Applications of trigonometry to velocities and forces and geometry are emphasized. Logarithms as a means of solution of problems are not introduced until near the end of the course, and the theoretical treatment of this subject is made the last chapter in the book. There is no treatment of DeMoivre's Theorem and its applications, and spherical trigonometry is not introduced. Answers are provided for some of the problems.

The book contains the very excellent tables of Professor Earl Raymond Hedrick. These include logarithms of numbers, logarithms of the trigonometric ratios, natural functions, powers, roots, hyperbolic functions, log haversines and proportional parts tables.

WALTER H. CARNAHAN

Biological Laboratory Technique, by H. Bronte Gatenby, Ph. D., Professor of Zoology and Comparative Anatomy, Trinity College, Dublin Uni-

versity. Cloth. Pages. vii+130. 13×20 cm. 1937. Chemical Publishing Company of N. Y., 148 Lafayette St., New York, N. Y. Price $3.00.

The author of this little handbook is one of the editors of the comprehensive work on the same subject, *The Microtomist's Vade-Mecum*. The chapter headings indicate the contents:

I Introduction. Laboratory Apparatus
II Treatment of Living Cells, Saline Media, Vital Staining
III Fixed and Stained Smears
IV Microchemical Tests in Smears
V Whole Mounts
VI Fixation Methods
VII Paraffin, Dioxan and N-Butyl Alcohol and Celloidin Imbedding
VIII Stains and Staining
IX Notes for Histology and Embryology Students, and Addenda

It is a very practical book full of useful suggestions to the beginner. Although most of the directions apply equally well to students in America and Britain, some of them, including references to other books and to supplies, are not up to date as regards the United States.

There are several drawings illustrating apparatus and methods. There is an index.

EDWARD C. COLIN

Socialized General Mathematics, by Walter W. Hart, Formerly Associate Professor of Mathematics, School of Education, University of Wisconsin, and Cottrell Gregory, Chairman Mathematics Curriculum Committee, Louisville, Kentucky. Cloth. Pages iii+406. 14.5×21 cm. 1937. D. C. Heath and Company, New York and Chicago. List price $1.28.

This book is designed expecially for that group of pupils who are not taking the customary courses in secondary mathematics. The beginning of the course requires no time for review, since skill and accuracy are expected to be improved through the use of mathematics in natural situations.

The text may be considered general mathematics, because the first part, consisting of ten chapters, deals with intuitive geometry, simple formulas, graphs, and equations, social mathematics, and indirect measurement. The second part is made up of the fundamentals of arithmetics. It contains many exercises to help the pupils improve themselves.

Four pages are devoted to an explanation of mathematics as the foundation of all sciences, the beginning of numbers, and mathematics in our social world.

Diagnostic tests appear within the book. Master tests are found at the end of nine of the ten chapters. Puzzles and games of chance follow the unit on leisure time problems.

The book has large sized pages, large type, many exercises, and is well illustrated with photographs, sketches, and drawings. Interesting pictographs are numerous. Intuitive geometry is made clear by definite drawings.

Both boys' and girls' interests are considered in this book. It is worth using as a text book.

FLORENCE D. GRAHAM

Mathematics and Life, Book 2, by G. M. Ruch, F. B. Knight, J. W. Studebaker. Cloth. Pages 5+512. 14×19.5 cm. 1937. Scott, Foresman & Company, New York and Chicago.

The two major objectives of this series are:

"1. the unification and socialization of mathematics

2. the development of insight into, and understanding of, the mathematical principles presented."

Book two deals with the mathematics of the community from the standpoint of the consumer, merchant, and banker. Space is devoted to the needs of the community and as to how these needs are satisfied.

As is typical of the Standard Service Series, by the same authors, there are many inventory tests, self-testing drills, and problem solving. One chapter is devoted to an inventory of the year's work.

The print is clear and readable and there are many illustrations. A top margin around some of the illustrations would be desirable. The book follows the latest trends in mathematics.

FLORENCE D. GRAHAM

Introduction to Mathematical Probability, by J. V. Uspensky, Professor of Mathematics, Stanford University. Cloth. Pages ix+411. 15×23 cm. 1937. McGraw-Hill Book Company, Inc. New York, N. Y. Price $5.00.

The theory of Probability is one of those phases of mathematical thought which are of unusual interest to the layman but of extreme difficulty for him to comprehend and apply. Even an introductory presentation of the theory involves mathematical principles which are accessible only to those who have had adequate training in advanced mathematics.

In this book Professor Uspensky has presented the theory by means of a series of problems which tend to illustrate the meaning of probability and to enable the student with a background in algebra, and the calculus to follow most of the reasoning. Teachers of mathematics interested in the subject will find in the book a wealth of useful information both in the theory of probability and in its applications.

J. S. GEORGES

Freshman Mathematics, by Herman L. Slobin, Professor of Mathematics, and Walter E. Wilbur, Associate Professor of Mathematics, the University of New Hampshire. Revised Edition. Cloth. Pages xx+584, 13×19.6 cm. 1938. Farrar and Rinehart, Inc. New York, N. Y. Price $3.50.

The present book is a revision of the author's previous edition (1932). The original plan of presenting algebra, trigonometry, and analytic geometry as a tandem course has been maintained in the revision. In Book I, three new chapters are added, namely, on variation, determinants, and infinite series. In Book II, new discussions on identities, equations, and complex numbers are added. In Book III, the implicit quadratic function, and lines in space receive added attention.

The many friends of the *Freshman Mathematics* who enjoyed using the earlier edition will no doubt welcome the new revised edition.

J. S. GEORGES

Elements of Statistical Method, by Albert E. Waugh, Professor of Economics, Connecticut State College. Cloth. Pages xv+381. 15×22.7 cm. 1938. McGraw-Hill Book Company, Inc. New York, N. Y. Price $3.50.

In this book the author presents the elements of statistics in a clear and simple manner. The treatment is that of the statistical method as such without its application to and interpretation in any special field. While the book contains a few derivations of formulas, the emphasis has been upon interpretation and illustration rather than upon mathematical proof.

The book is well written and the format is excellent. The student of elementary statistics will find the classical concepts and processes of the subject well illustrated.

J. S. GEORGES

A Text Book of the Differential Calculus, by S. Mitra and G. K. Dutt, Calcutta, India. Cloth. Pages xiv+302. 5×7 9/16 in. 1937. W. Heffer and Sons Ltd. Cambridge, England. American price $4.00.

"The want of a suitable book on the Infinitesimal Calculus in the English language has been felt keenly by almost all teachers in the universities of India." In this book the authors hope that they have adequately met this need. The book deals with many topics which are not usually treated in American texts on the Differential Calculus as the following list of topics shows: Variables, real and complex; Bounds, limits, convergences; Functions of real variables; Infinitesimals and their fundamental properties; Derivatives and differentials; Successive differentiation; Taylor's and Maclaurin's Theorems; Indeterminate forms; Partial derivatives and differentials; Maxima and minima; Implicit functions; Change of variables; Tangents and normals; Asymptotes; Envelopes; Curvature; Curve-tracing.

Though not suited for a text in American schools, the text may be used as reference book by the teachers of the calculus.

J. S. GEORGES

The Number-System of Algebra, Treated Theoretically and Historically, by Henry B. Fine, Professor of Mathematics, Princeton. Reprint from 1890 Edition. Cloth. Pages ix+131. 5×7¾ in. 1937. G. E. Stichert and Company, New York, N. Y.

The teachers of mathematics who have used Fine's The Number-System of Algebra for many years as a source of useful information on algebraic principles and their historical development will welcome this reprint. The teacher of elementary algebra will enrich his background in the subject to make himself familiar with the theoretical treatment of the concepts of algebra presented in this book. The student of algebra will have a keen appreciation of the subject if he pays due attention to the historical development of the science of algebra presented in the second part of the book.

A library of elementary mathematics which did not contain the original of this little book should fill that vacancy by the present reprint.

J. S. GEORGES

STORAGE POSSIBILITIES ON NEHALEM RIVER, OREGON

A contour map of Nehalem River from Mohler to Timber, Ore., a stretch of 102 miles, has just been released by the Geological Survey, United States Department of the Interior. This map was surveyed on a scale of 2 inches to the mile with contour intervals of 20 feet on land and 5 feet on the river surface. The map shows the course of the stream, the contour of the valley bottom and immediately adjacent slopes, houses, and roads. The survey was made especially for determining the amount of storage that could be developed on the stream and the amount of head that would be available for power development. The map shows that a 205-foot dam might be constructed at a point near Elsie Post Office, where the Wolf Creek highway crosses the Nehalem River, that would back water to Vernonia, creating a lake 50 miles long and an average of about three-quarters of a mile wide. This lake would have a total capacity of about 1,500,000 acre-feet, which could be developed for power at several dam sites between Elsie Post Office and Mohler. This map may be consulted at the field office of the Geological Survey, 606 Post Office Building, Portland, Ore., or may be purchased for 10 cents a sheet or 70 cents for the set of seven sheets from the Geological Survey, Washington, D. C.